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Dissolved Gases in Glass

By S. R. Scholes*

The purpose of the present article is not to give the results of scientific investigation, or to review intensively the literature of the subject. It is rather to introduce for general discussion a phenomenon that has apparently not received the attention that its effects deserve. To this end the writer presents the summary of a number of observations by himself and others, hoping that their collective meaning may be seen to have some value for the operators of glass furnaces, and that further observations may be stimulated.

The melting process gives rise to the evolution of large quantities of gas, chiefly made up of carbon dioxide from the decomposition of carbonates. Also, the batch has trapped within itself a good deal of ordinary air, so that oxygen and nitrogen are among the gases rising in bubbles as the glass plains off. It might reasonably be supposed that the high temperatures employed would be sufficient to drive off all these gases, and that when the last visible bubble had disappeared, no further evolution of gas could be expected.

However, this is not the case, and it must be recognized that small but appreciable quantities of substances which are gases at ordinary temperatures, to say nothing of the temperature of molten glass, remain in a state of true solution in the glass.

The first intimation of this fact coming to the writer's attention was in the statement of an old glassmaker that if a certain pot which was being worked were shut up again and reheated, the glass would "go into a second boil." Needless to say, this statement was skeptically received. But the result confirmed it. Whatever the cause or the scientific explanation, reheating the pot did make it seedy again, and prolonged heating was necessary to drive out these small seeds and make the glass plain a second time.

Another bit of common experience in pot-practice is the fact that the last few small bubbles in a pot are not removed until the pot is opened and the glass cooled somewhat below the heat it reached during earlier stages. That is to say, continued heating seems to generate small amounts of gas, thus defeating its object.

Again, the application of intense heat to clear glass, as in the laboratory working of glass tubing, or in certain factory operations, has been seen to cause the appearance of tiny bubbles.

Dr. E. W. Washburn, of the University of Illinois, was the first to make a scientific demonstration of the presence and character of the gases dissolved in glass, by melting the material in a vacuum furnace.

This phenomenon is by no means a mere scientific fact, unrelated to the commercial processing of glass. On the contrary, it can be shown to have a pronounced relation to the "nature" of the glass, and its recognition may serve to explain some phases of the working of glass not otherwise easy to understand.

Most glassmakers and factory superintendents are familiar with the remark of glassworkers at certain times to the effect that the glass has "no nature to it" or is "hard-natured." Like all repeated observations of experienced men, this remark, however poorly expressed, describes something real. At such times the glass is of higher viscosity at the usual gathering temperature, requiring a harder twist of the pipe or punty to gather it. It sets faster, so that less time can be spent in shaping it, and hasty work is necessary. Finally, at a higher temperature than usual, it becomes too rigid to work.

If automatic ware is being made from glass in this condition, the shears do not cut as cleanly; higher pressures on rams and blow-heads are required; and strained and checked edges are more common in pressed ware.

The glass behaves, at such times, as though more lime had been added to the batch, or less soda than usual.

To be sure, a careful check-up of batch and raw materials, even a chemical analysis of the glass, will not reveal a variation from the usual composition to account for the change in viscosity or working properties noticed by those who gather or work the glass. This is what makes the glasshouse chemist often treat such remarks as to glass "nature" as "alibis" and turn a deaf ear until the complaint is dropped.

But what are accompanying or preceding conditions, when the glass exhibits to the glassworker this stubborn character?

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To borrow his English, when the glass has "had the nature burnt out of it" by long heating; as when work is resumed on a tank after Sunday or holiday or other shut-down. Again, when a slower pull on the tank has brought relatively older glass to the work-hole. Another accompanying condition is the use of more than the usual amount of cullet.

It is at once apparent that each of these contingent circumstances has been conducive to the more complete removal of the dissolved gases from the glass. On the other hand, seedy glass, however undesirable it may be in the finished ware, is sweet-natured to the glassworker. And seedy glass is of course more nearly saturated with dissolved gases.

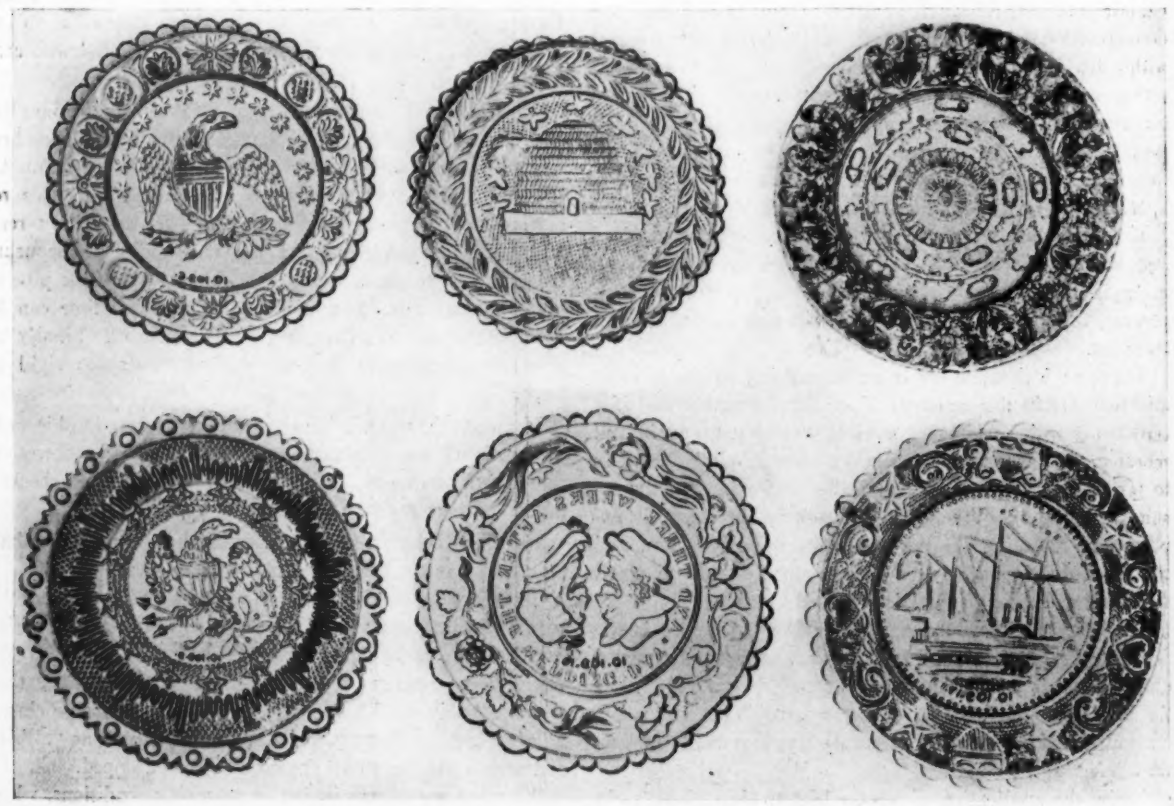
It seems safe to conjecture that here may be recognized an influence on the viscosity of glass at working temperatures that is worthy of study; and like all other conditions, it must be brought under control, as glassmaking becomes more scientific.

The question may fairly be raised, how such minute quantities of matter, so imponderable as to be missed in a chemical analysis, could have an appreciable effect on the glass. This can best be answered by considering the dissolved gases as true members of the complex solution which is glass. The influence of each member of the glass solution on the viscosity of the glass depends upon the melting point of that member. For example, silica has a high melting point, and an increase in silica percentage is manifest by increased viscosity. The same is true for alumina, lime and magnesia. The fluxing oxides, soda, potash, and boric oxide, lower the viscosity. Soda is particularly active in this direction. Its melting point (as oxide) lies near 900° F., or just below red heat.

Gases such as carbon dioxide, oxygen, and nitrogen are at ordinary temperatures far above their melting points. Carbon dioxide melts at -70° F. If soda with a melting point of 900° F. is such a powerful flux and softener of glass, what must be the action of carbon dioxide, melting as far below soda as the latter melts below the normal working temperature of glass! We need only mention the melting temperatures of oxygen, -376° F., and nitrogen, -346° F., to show how in this argument they can be regarded as the most active fluxes obtainable.

It has been common, from the standpoint of the physical chemist, to regard glass as a product in which all chemical and physical changes possible at the final working temperature are complete. That is, equilibrium has been reached. This seems reasonable, because of the fact that glass has been heated at a high temperature for many hours, even for days, and has become a quiet fusion, free from all but a very few bubbles of gas.

However, in the light of the facts as to the dependence of working properties on heating time and other conditions unrelated to batch composition, a revision of this view seems necessary. How to avoid variable viscosity in the glass as worked, and how to turn to advantage the effect of dissolved gases, become problems for the glassmaker to work out.



EARLY AMERICAN GLASSWARE AT THE METROPOLITAN MUSEUM OF ART
CUP PLATES OF PRESSED GLASS—19TH CENTURY

New Plant of Sheffield Glass Bottle Company

A Typical Factory for the Production of Bottles by Approved Modern Methods

The newly built and completely equipped factory of the Sheffield Glass Bottle Company at Sheffield, Pennsylvania, erected to replace the old plant destroyed by fire early this year and which has been in operation for over two months is the latest enterprise of its class to be completed and put into smooth-running production.

This plant exemplifies the art of bottle making by the use of modern equipment and methods.

The Company manufactures practically all kinds of bottles running in size from one dram to quarts, inclusive, also wide mouth food containers and other items, and specializes in prescription and toilet lines.

All the flint glass products are made in the Sheffield factory and amber glass orders are taken care of at their Wilcox, Pennsylvania, plant situated a few miles from Sheffield, and equipped with three O'Neill automatic machines with O'Neill feeders. The other equipment in this plant is also similar to that of the Sheffield plant.

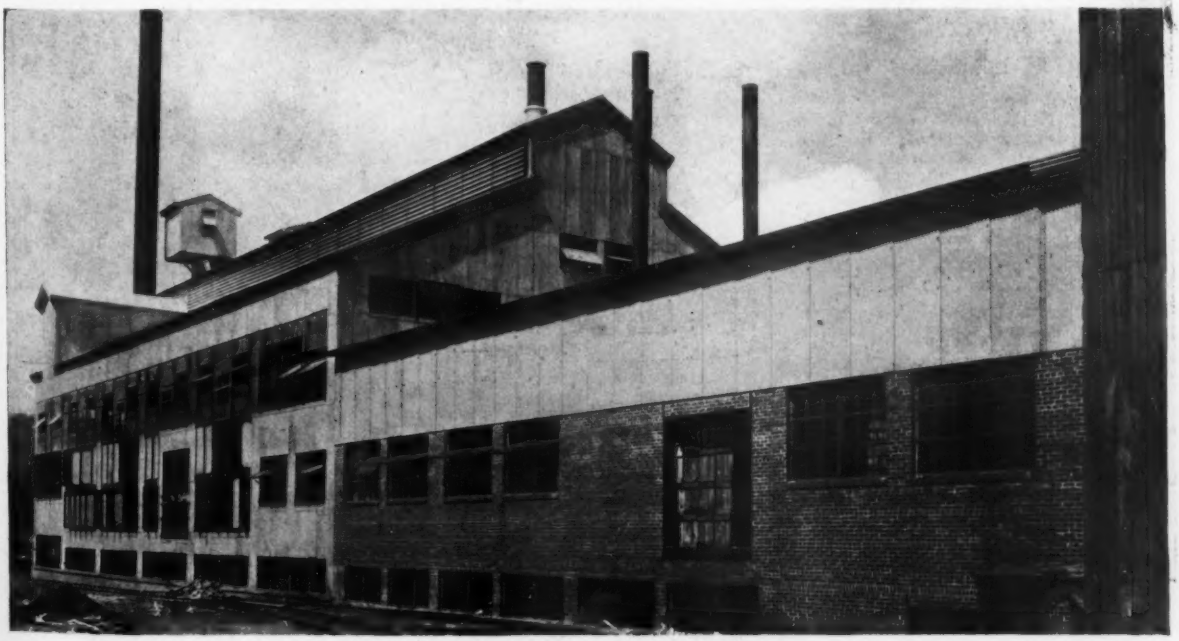
The new Sheffield plant is of special interest because of the comparatively short time that elapsed between the destruction by fire of the old plant, which occurred on January 29, 1926, and the beginning of manufacturing operations in the new plant on May 17. The period of two weeks immediately after the fire was occupied in adjusting the insurance. Meantime, on January 30, the decision to proceed with the construction of a new plant was made. The Simplex Engineering Company, of Washington, Pennsylvania, was retained, plans were prepared under the direction of C. E. Frazier, president of that Company, and construction work began on February 17. Fire was lighted in the tank on April 20 and the making of bottles began, as before stated, on May 17.

The plant includes a complete new 35-ton regenerative tank, and two Simplex continuous muffle lehrs. The fireproof building is of entirely new construction as are also the modern batch plant and power plant.

The furnace building is 60 by 120 feet in size with a basement under the entire area. The factory floor is 10 feet above the basement floor, and 25 feet above the factory floor is the bottom chord of the roof trusses.

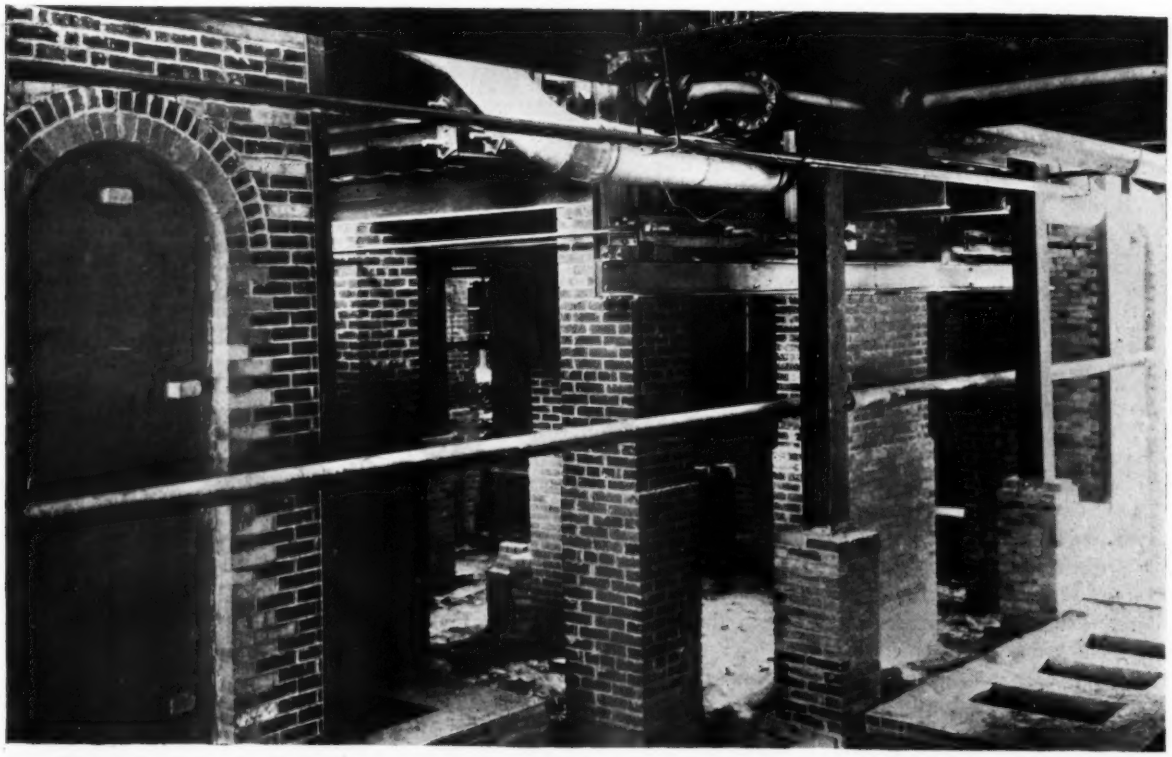
The tank is equipped with high efficiency ports and a submerged throat which so far has been working very satisfactorily. The pyrometer equipment includes both indicating and recording instruments.

There are installed six O'Neill feeders and six O'Neill automatic machines of the most recent type. To the rear, in addition to the batch plant there is installed a modern batch handling and storage plant, all material being unloaded mechanically by means of Columbus Conveyor Company equipment. Underneath the storage bins which have a capacity of about 30 carloads of material, there is a gather-



NEW PLANT OF SHEFFIELD GLASS BOTTLE COMPANY
Furnace Building and Packing Room.

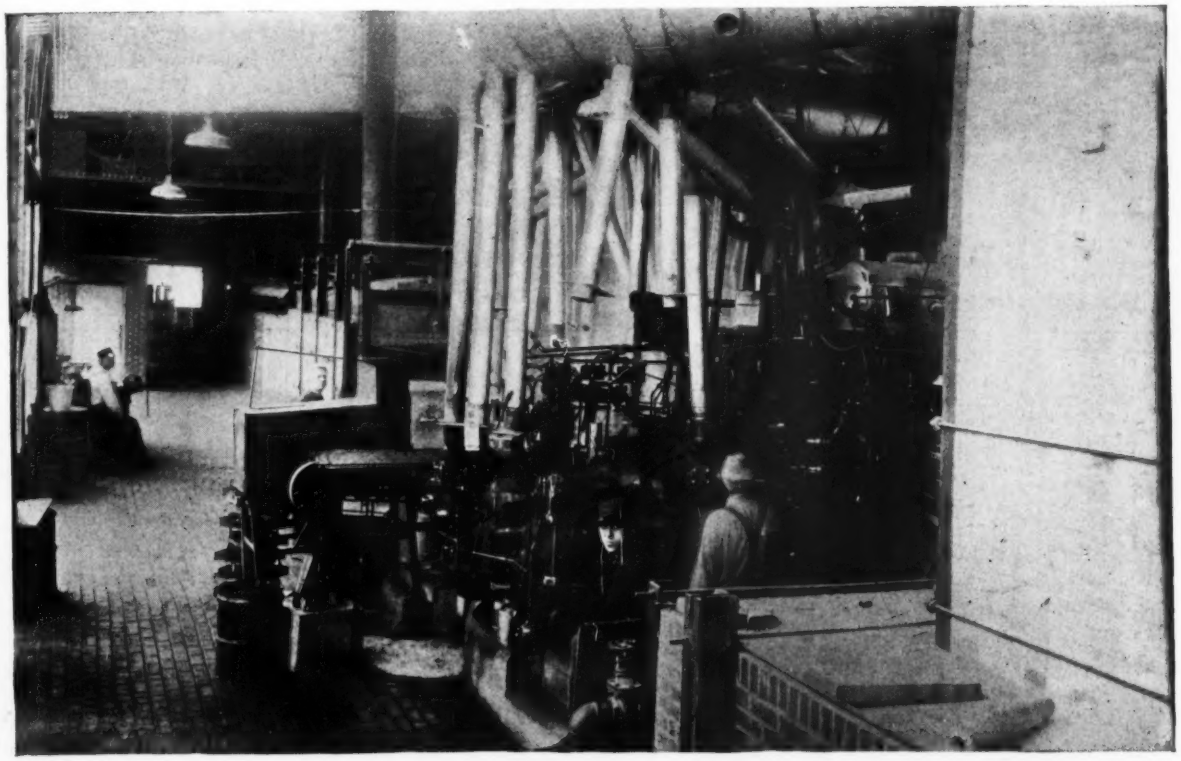
NEW PLANT OF SHEFFIELD



UPPER—VIEW UNDERNEATH CONTINUOUS TANK SHOWING AIR REGENERATOR AT LEFT AND TANK PIERS, WIND SYSTEM, ETC.

LOWER—BESSEMER OIL DRIVEN COMPRESSORS IN ENGINE ROOM SUPPLYING AIR FOR THE FACTORY'S REQUIREMENTS.

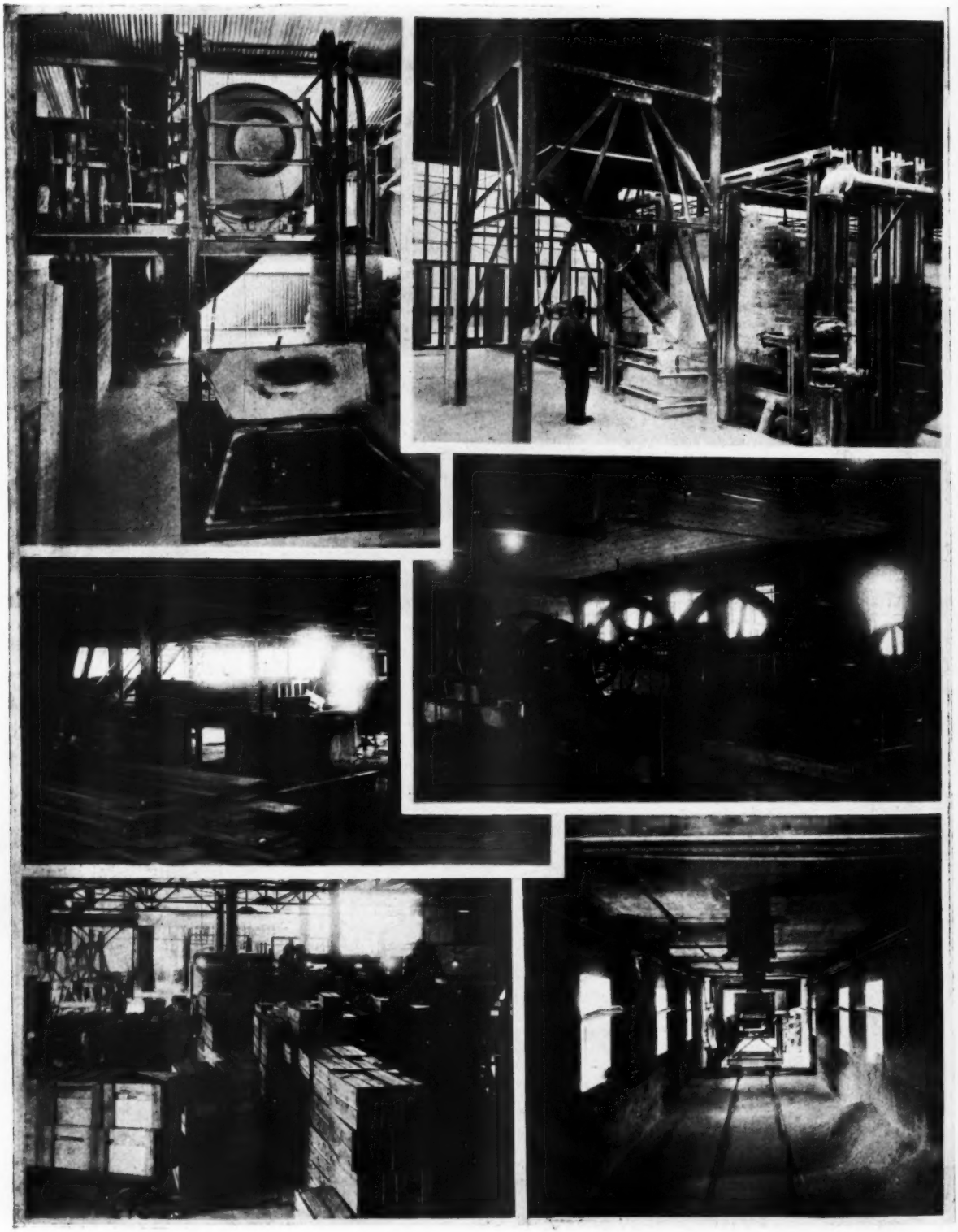
GLASS BOTTLE COMPANY



UPPER—SIDE VIEW OF WORKING END OF TANK SHOWING O'NEILL FEEDERS AND AUTOMATIC MACHINES. HOT END OF LEHR IN THE BACKGROUND.

LOWER—WORKING END OF TANK SHOWING AUTOMATIC BLOWING MACHINES; "PEANUT OVEN" AND WIND SYSTEM.

NEW PLANT OF SHEFFIELD GLASS BOTTLE COMPANY



UPPER LEFT—MOTOR DRIVEN BATCH MIXER. CENTER—BOX SHOP WITH BOX MAKING MACHINES LOCATED DIRECTLY UNDERNEATH PACKING ROOM. LOWER—PACKING ROOM SHOWING CONVEYOR WHICH DELIVERS CRATES FROM BOX SHOP BELOW

UPPER RIGHT—MIXED BATCH STORAGE BIN AND FILLING-IN END OF TANK. CENTER—BESSEMER OIL DRIVEN ALTERNATORS IN POWER HOUSE. LOWER—GATHERING AND WEIGHING BATCH CAR IN TUNNEL BELOW BATCH MATERIALS STORAGE BIN.

ing and weighing car which carries the batch to a rotary mixer from which point it is mixed and delivered into an elevator which carries it up to a storage bin situated at the rear of the furnace. In the batch storage building there is a storage bin for cullet, which runs through a Wheeling Mold and Foundry Company crusher and over a magnetic separator and is elevated into the bin, this being mixed with the batch and elevated into the storage bin to the rear of the tank, ready for feeding directly into the tank through an inclined chute to the doghouse.

The lehr building is of the same general type of construction as the furnace building, being fireproof throughout, and is 65 feet long and 60 feet wide. The ceiling height is 14 feet above the factory floor and the packing room is of the same construction as the lehr building, 60 by 100 feet in size. Underneath the packing room is a basement 10 feet high wherein shook storage is provided and boxes and crates are manufactured, these being elevated to the cold end of the lehrs on an Alvey conveyor manufactured by the Alvey Manufacturing Company of St. Louis, Missouri. The elaborate wind system of sheet metal pipes serving the tank and automatic machines was constructed by Metzger-Wright Company, Sheffield, Pennsylvania.

The Sheffield Company is a strong believer in the use of "peanut ovens" in which the bottles are placed immediately upon removal from the molds to keep them hot pending their transfer to the lehr. This work is done by hand as no conveyor has been found sufficiently flexible in operation to handle the many different sizes and shapes produced in this factory. According to the general manager, Mr. Keefer, a reduction in losses of 10 per cent has been effected by the use of the oven, one of which is provided for each machine.

The power plant consists of two 125 KW. 220 volt, 3 phase, 60 cycle Ridgway alternators direct connected to Bessemer Diesel oil engines, these being installed in duplicate. In addition to this there are installed two Bessemer Diesel type oil driven air compressors, each of which has a capacity of 650 cubic feet per minute. Besides the oil driven compressors there is a Chicago Pneumatic belt driven compressor, driven by an AC motor, which acts as a reserve unit and permits the operation of either the electrically-driven or the oil driven compressors.

Due to shortage in the winter months of natural gas, an emergency fuel oil system was installed which makes possible the operation of the lehrs and tank by fuel oil.

The general layout of the plant has been so designed that a twin plant can readily be built alongside the one completed, should occasion arise for increasing production facilities or for moving the Wilcox plant to Sheffield.

The Company was able to make a very successful start in operations in a comparatively short time after the loss of their old plant. Considering the conditions under which the erection of the plant was carried on, remarkable headway was made as ninety-two days only were consumed in getting it in operation, in spite of the fact that Sheffield is located in a very cold part of the country. The past winter was an extremely cold one, and snow and ice an obstacle that had to be overcome throughout the entire period of construction.

Co-operation played an effective part in advancing the progress of construction. Officers, directors, and employees worked untiringly to get the plant completed. Workmen, who before used to operate machines to make bottles, used pick and shovel, drove mule teams and did everything asked in order to get back to work in the new structure.

The Sheffield Glass Bottle Company has been making bottles for over fifty years. Running at full capacity it employs in its two plants about 225 men and produces about five carloads of bottles a day. Before the War the Company did a large export business but this has entirely disappeared due to the low prices quoted on foreign bottles made in other countries, where wages and the standard of living are lower. In Cuba, for instance, German bottles are sold at prices below cost in this country, so inevitably the formerly large Cuban trade has been lost.

The present officers of the Company are George L. Craft, president; C. H. Smith, vice-president; W. B. Keefer, secretary-treasurer and general manager; J. G. Smith, assistant-manager and purchasing agent, and L. S. Carroll, assistant-treasurer. The capital of the Company was increased a short time ago from $130,000 to $450,000.

Note on the Use of Uranium Compounds

BY THEODORE LENCHNER*

The chief use of uranium compounds at present is in the manufacture of greenish to yellow glass or glaze. For this purpose the chemical sodium uranate has generally been used, although the use of oxide has lately come into prominence.

There, however, seems to be a misunderstanding regarding the nomenclature of these materials. Such names as Yellow Uranium Oxide, Uranium Yellow or Orange, Sodium Uranate, and Uranium Oxide are identified with the same material. The existence of a commercial Uranium Oxide seems to complicate matters still further.

The Sodium Uranate of commerce is a yellow to orange product with the formula Na_4UO_4. Many users will specify the color of the product desired as either yellow or orange. However, the writer fails to see why the user should prefer one color to the other. The value of Sodium Uranate is expressed in terms of the Uranic Oxide, U_3O_8. The U_3O_8 content is usually from 75 to 80 per cent. This product should be designated as Sodium Uranate and if there is a preference as to color it should be so stated.

The Uranium Oxide of commerce is the black Uranium Dioxide UO_2. Here again its contents are expressed in terms of U_3O_8 (Uranic Oxide) which oxide is one of the most stable of the Uranium oxides. Therefore the term Oxide should be used only in connection with the Black Uranium Dioxide.

There has appeared lately in the market another salt of uranium known as Sodium Uranyl Carbonate. This is a greenish yellow material with a U_3O_8 content of 48 to 50 per cent. This material on account of its lower cost may eventually replace the more expensive Sodium Uranate, especially when used in coloring of glass. Several large manufacturers of the uranium colored glasses are using this material successfully.

* Vitro Mfg. Company, Pittsburgh.

The Function of Lime in Glass

A Discussion of the Forms of Lime Available to the Glass Manufacturer and a Comparison of Their Costs

By D. J. McSwiney*

In the words of an old glassmaker, "The sand gives the glass, the soda makes it melt, and the lime give it nature." The function of the lime in glass is to render it more insoluble, so that it can be used in contact with water or materials containing water and so that it will not bloom quickly from atmospheric action, to improve the melting and working properties of the glass, to make it less brittle and mechanically stronger, to improve its appearance by giving it a greater and more enduring luster, and to lessen its cost. Many of these properties can be given to glass by the use of other materials such as lead oxide, boric oxide, zinc oxide, etc., but there is no other material which combines these advantages to any great degree with the cheapness and availability of lime.

Although a mixture of pure sand and lime requires for melting a temperature much higher than that used for melting glass, the lime added to a glass batch ordinarily acts as a flux towards the sand. As the rate of combination of silica and lime at glass melting temperatures is very much slower than the rate at which they combine in a glass melt, it is probable that the combination of the two materials does not take place directly to any extent, but rather through the medium of the fused alkali silicate present, the lime combining with silica which has already been dissolved, and allowing more rapid solution of the remaining silica by the soda or alkali silicate.

Lime Cheapest Fluxing Material

As lime is the cheapest basic or fluxing material available, the tendency is, in those glasses where batch cost is a main consideration, to carry as high a lime content as possible. The amount of lime which can be used in a glass is determined largely by the way in which the glass is to be worked and on the size of ware to be formed. The factor which has the greatest influence in limiting the amount of lime is the setting rate of the glass. As the amount of lime in a glass is increased, the setting rate increases rapidly.

Increase in the lime content of a glass increases its tendency to devitrify through the separation of crystalline calcium silicate. This however is not of great importance in the glass made in this country, as under normal operation devitrification seldom if ever develops, even in flat glasses of high lime content. This is shown by the fact that under normal operation devitrification does not develop at those points where conditions are most favorable for its development. For example, in flat glass tanks which are often as much as five feet in depth and in which the glass may carry as high as fifteen per cent of lime, the points most favorable for the development of devitrification are the quiet parts of the front of the tank, especially near the bottom but far enough from the block that it will acquire but little alumina through block corrosion. At this point the glass will be nearest the temperature range of maximum devitrification speed and, as the glass at this point moves only very slowly, it will remain for a much longer time under the influence of this temperature than the glass in any other part of the tank. Yet in quarrying out such a tank the glass will normally be found clean and free from crystalline material throughout the working end. Most scummy or crystalline materials found in tanks are found on or near the surface of the glass, that is at the point where, owing to the high temperature and the high rate of flow, conditions are not favorable for devitrification. Many large window glass tanks take as long as two weeks to cool down; in these cases crystalline material will normally be found only on the surface where devitrification is least likely to take place owing to the cooling being most rapid at this point. The center of the mass of glass where the rate of cooling is very slow will normally be free from the products of devitrification.

By far the greater part of non-vitreous materials found in glass tanks is batch scum due to the incomplete assimilation of some of the batch materials.

Very little hydrated lime is at present being used; the only advantage this material could claim over the other forms of lime is greater fineness and, from a practical standpoint, this is of very doubtful value.

Raw Lime Versus Burnt Lime

Practically all flat glass is made from raw lime, as is also the case with a large portion of the containers made in this country. Burnt lime is used for the greater part of the flint containers and tableware.

The chief factor which recommends the use of raw lime is cheapness. The price of burnt lime is from three to eight times that of raw lime, but the difference between the cost of the two, per unit of lime in the glass, is ordinarily not nearly as great as this. The much higher cost of burnt lime is due partly to the fuel required for burning the lime in the kiln and partly to the fact that burnt lime is a more condensed form—only about fifty-five parts burnt lime being obtained from one hundred parts raw lime.

The decomposition pressure of limestone at glass melting temperatures is more than four hundred pounds per square inch. Because the decomposition of limestone requires heat it is probable that the particles of limestone in the batch do not come quite to the tank temperature until their decomposition is nearly completed. However, owing to its high decomposition pressure at high temperatures, it is probable that the burning of the lime is quickly effected in the ordinary soda lime glass furnace where the pressure is low and it can decompose freely. Each particle of decomposing limestone is the focus of an out rushing stream of gas formed in its decomposition. It is therefore doubtful if any contact ob-

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tains between the limestone and the silica in the batch or glass at a temperature high enough to effect interaction between them. Probably, the limestone decomposes completely and the lime formed from it then reacts with the silica. So that, for all practical purposes, the lime must be burnt whether in the kiln or in the tank.

When fully burnt, any raw lime will always give the same amount of burnt lime wherever and however the burning is effected. The actual amount of burnt lime produced will depend on the purity of the limestone. A pure limestone would give fifty-six parts burnt lime while a pure dolomite would give about fifty-two parts dolomitic or magnesian lime. Limestones or dolomites are never entirely pure but always contain varying amounts of moisture, silica, alumina and other ingredients. Commercial burnt lime is never completely burnt and although burnt limes from some companies contain less than one per cent volatile matter or "loss on ignition," the amount of ignition loss on poorly burnt limes may run higher than ten per cent.

Cost of Limestone

The cost of using limestone as a source of lime in glass includes the cost of quarrying and grinding the stone, the freight cost, cost of storage, and cost of burning the stone in the glass tank. The quarrying cost is practically the same in the case of stone to be burnt and that to be ground. Limerock to be burned in the kilns is usually broken in pieces from three to eight inches in diameter. Glass limestone, however, must be ground to finer than eight mesh. Many limestones suitable for glass manufacture are used for road stone and the fines from the crusher run of such rocks being often in excess over that needed for road purposes, these fines could be used for glass limestone. Ground limestone from this source is however, not always available and is never available in a quantity sufficient to supply the demand for glass limestone. In the case of a tough stone, grinding to a size suitable for glass limestone may add appreciably to the cost of the raw lime, while the limerock for burning is broken only into coarse lumps and the burnt lumps are easily pulverized.

In every hundred pounds of ground limestone on which freight is paid, there are from forty to forty-five pounds which will not add to the amount of glass made, but instead will be lost up the stack. Where lime material must be shipped a considerable distance the fact that freight must be paid on one hundred pounds of raw lime to get the equivalent of fifty-five pounds of burnt lime may lessen considerably the difference in cost between burnt and raw lime in the batch. However, in many cases this is largely offset by the freight rate on burnt lime being higher than that on raw lime.

Ground limestone packs better than burnt lime as they are usually filled into bins, so that on an average one hundred pounds of ground limestone will occupy the same space as about sixty-five pounds of burnt lime. In proportion to the lime content, the burnt lime requires slightly less storage space than raw lime. However, while burnt lime must be protected from the weather, raw lime is unaffected by rain and does not change in composition as burnt lime does. Burnt lime packed in containers such as barrels or sacks which are not impervious to moisture swells up within a short time through absorption of moisture to such an extent as to burst the container. The rate of absorption of moisture by the lime is greatly lessened when the lime is burnt at a very high temperature. High calcium lime absorbs moisture much more rapidly than magnesian lime and will give more trouble in this respect. The absorption of moisture by the lime sets free a considerable amount of heat and, although the danger is ordinarily only very slight, fires have been caused by the absorption of moisture by high calcium lime under favorable conditions. Where the lime is stored in an air-tight concrete or steel bin and only one surface exposed to the atmosphere, absorption of moisture may take place quickly on the exposed surface but, as this absorption falls off rapidly below the surface, the amount of moisture absorbed by the entire mass will be small even over a considerable length of time.

The amount of heat theoretically necessary for burning limestone is the same for a definite quantity of stone at the same temperature, whether the burning is effected in the kiln or in the tank. As the temperature at which the limestone is burned in the tank is higher than that at which it is burned in the kiln, the amount of heat actually required for the change from raw to burned lime is somewhat greater in the tank than in the kiln through a greater amount of heat being needed to raise the stone to the burning temperature and through a somewhat greater heat loss resulting from the gas formed in the burning at a higher temperature. However, this is offset by the fact that the sensible heat of the lime in the kiln at the burning temperature is rendered nonavailable when the lime is cooled after burning, so that it must be reheated in the glass tank. The amount of heat required for burning the limestone in the tank is near that theoretically necessary to bring the stone to the burning temperature, to effect the change from raw to burnt lime, and to supply the extra heat lost through the gas from the stone. The heat necessary for the decomposition in the kiln is always much higher than the theoretical amount owing to the fact that as the stone burnt is relatively large and the temperature rather low, the rate of decomposition in the kiln is slow. To remove the gas formed in the decomposition so as to allow the burning to proceed to near completion a draft is necessary through the pile of lime.

The fuel used in burning the lime must enter into the cost of the lime whether the burning is carried out in the tank or the kiln. The price of the fuel used in the tank is ordinarily greater than that used in the kiln, but owing to the fact that the thermal efficiency of burning in the kiln is low while burning the lime in the tank requires nearly the theoretical amount of heat, the actual fuel cost of kiln burnt lime is almost invariably much higher than that of tank burned lime. So that, from a thermal standpoint, there is no objection to "using a glass tank as a lime kiln."

One of the chief claims made for the use of raw lime is that the gas evolution from the lime acts as an agitating or stirring agent, and promotes the formation of a more rapid and homogeneous melt. In what little work has been done to compare the action of raw and burnt lime in flat glass where up to 700 lbs. coarsely ground limestone per ton of

sand is used, there is some slight evidence that a more homogeneous melt may be obtained with raw lime, but with glasses such as those for containers where on an average of about 400 lbs. of finer limestone is used, glass formed from burnt lime is invariably as homogeneous as that from raw lime under the same melting and working conditions and under the highest pull attained on such tanks.

With materials of medium fineness, a burnt lime batch will melt somewhat more rapidly than a raw lime batch, probably because the latter heats up more slowly than the former and because solution of the limestone particles is not rapid until the particles are almost completely burned. Moreover, the evolution of carbon dioxide from the decomposition of the lime and that from the interaction of the soda ash and sand will mutually tend to slow up each of these actions to some extent. With very coarse particles, complete solution is effected more rapidly with raw lime than with burnt lime, probably because the decomposition of the limestone tends to break up the large particles and thus allows more rapid solution. For this reason with batches of the same lime content and melted under the same conditions, the tendency for scum formation is less with raw lime than with burnt lime, and while limestone is often used with success as coarse as eight mesh, burnt lime cannot be safely used coarser than twenty mesh. A burnt lime particle which can be very easily crumbled in the fingers will have sufficient coherence to withstand any pulverizing action to which it might be subjected in the mixing of the batch or filling into the tank.

Gas Formed During Melting Process

In a batch containing 750 lbs. soda ash and 400 lbs. of limestone per ton of sand, the action of the soda ash on the sand sets free an amount of gas equal at melting temperatures to about 1000 times the volume of the glass formed, while the gas set free from the limestone equals about 550 times the volume of the glass. It would seem that if the 1000 volumes of gas from the soda ash were not sufficient to thoroughly agitate the melting mass, that the additional 550 volumes from the limestone would not effect the complete agitation unless all or part of the gas evolution from the limestone took place after the gas evolution from the soda ash had been completed. It is possible that when a very large amount of coarse limestone is used in the batch, as is the case with some flat glasses, some of the gas evolution from the limestone may take place after the evolution of gas from the soda ash has ceased, but in the ordinary container glass batch where a moderate amount of rather fine stone is used it is probable that the gas pressure from the decomposing limestone is greater than that from the soda ash and that the decomposition of the limestone is completed before all the soda ash has reacted with sand of the character ordinarily used.

If the decomposition of the limestone is continued any length of time after the completion of the soda ash reaction it will tend to lengthen the refining period. However, there is no evidence that the refining period is longer with raw lime than with burnt lime batches. The speed at which the refining takes place determines the length of time the glass must remain in the tank—that is the allowable pull—more than does the rate of melting. It is not possible to say whether the allowable pull on a burnt lime batch is greater than that on a raw lime batch, because there are many other factors besides temperature and batch composition which determine the allowable pull. The pull on glass tanks is probably never as great as would be possible under most favorable conditions. Consider, for example, the case of a flat glass tank melting and refining glass at the rate of a ton per day per eight square feet of melting surface from a batch containing more than 700 lbs. raw lime per ton of sand, while the average glass manufacturer melting at about the same temperature a batch containing about 200 lbs. burnt lime will claim that he cannot melt more than a ton per day per twelve square feet without getting seedy glass. The greatest pull maintained on glass tanks melting a batch containing about 400 lbs. limestone per ton of sand or its equivalent in burnt lime is a ton per day per 6½ to 8 sq. ft. of melting surface, and this pull is attained with raw lime batches as well as with those using burnt lime.

Burnt Lime Best for Flint Glass

Where very high grade flint glass is desired, burnt lime is most often used because experience has shown that on the average, the color of glass from a burnt lime batch is better than that from raw lime. Because of this, burnt lime is often shipped a considerable distance in preference to a local raw lime. The better color given by burnt lime batches is not due to a lower iron content in the burnt lime for even when the same amount of iron is introduced in each case the color of the burnt lime glass will usually be better than that from the raw lime. The superior color of the burnt lime glasses is not due for the most part to the use of less decolorizer, but shows as an increased brilliance or transparency probably resulting largely from the absence from the burnt lime of impurities commonly present in the raw lime, and to the fact that all the iron in the burnt lime is in the ferric condition while that in raw lime is often largely ferrous. The impurities in raw lime which ordinarily affect the color of the glass are organic material, sulphides and metallic iron. The presence in the batch of a relatively small amount of organic matter has a pronounced effect on the brilliancy of the glass. Burnt lime ordinarily has a much higher content of sulphur than raw lime owing to absorption of sulphur dioxide from the coal gases during the burning. However, while the sulphur in the raw lime may often be present as sulphide which can have a strong coloring power, that in burnt lime is usually present entirely as sulphite, which, in the absence of strong reducing conditions, has no coloring power in glass.

In the grinding of one dolomite to a fineness suitable for glass, the ground material had more than double the content of iron contained in the original rock, through introduction of metallic iron in the grinding. This, of course is exceptional for dolomites are almost always very much tougher than limestones and the amount of metallic iron introduced in the grinding of a coarsely crystalline limestone may be very small. However, as fine metallic iron appears to have an excessive coloring action the presence of an excessive amount of it in raw limestone is a disadvantage.

It is true that some raw limes can give as good if not a better color than the average burnt lime but, for the same amount of iron introduced into the glass, the color given by the average burnt lime is almost invariably better than that given by the average raw lime. Some raw lime is so soft that it can be pulverized without introducing metallic iron, since its iron content is almost entirely ferric it appears to show a cleaner color than limestones of the same iron content in which the iron is largely ferrous.

Burnt limes used in glass are classified as high calcium limes and dolomitic or high magnesian limes, dependent on their content of magnesia. High calcium lime has a magnesia content of less than five per cent, while the magnesia content of dolomitic lines runs from thirty-five to forty-two per cent. Both give the same results as regards improved color, but the dolomitic lime is usually preferred because it is more easily handled and stored. Its composition remains more constant, it gives a glass which works better on rapid forming machines, and the introduction of magnesia into the glass improves its resistance to heat shock and its mechanical properties. A glass formed from a dolomitic lime is somewhat more fluid near melting temperatures than is a glass from a high calcium lime.

As the cost of raw lime is less than that of burnt lime when all factors are considered, it is probable that it will always be used as a source of lime in glasses where batch cost is a most important item. As burnt lime tends to give a better color than raw lime, its use in this country will probably continue especially in the numerous cases where a very high grade flint color is essential, and where there is no local source of limestone of very low iron, organic and sulphide content.

A Few Points on Gas Producer Costs*

By James A. Voorhies

It is of interest to consider the raw gas bituminous producer the use of which is so widely adopted in the industrial field as a small and convenient form of gas plant. Too many who install such equipment regard it as they would an oxy-acetylene gas tank. They feel that by merely turning the valve, gas may be had and that it requires a man or two to clean up the mess. This attitude is entirely wrong and leads to the many errors and troubles so often complained of by those incompetent men who lay claim to a knowledge of all industrial operations within a plant.

Producer gas generation has its phases of costs and maintenance with just as delicate a form of operation, both chemical and mechanical, as the production of steam and electrical power. So that to cheapen the process, the very first plans of installation are the most vital. Items to bear in mind at this point in planning the proposed units are:

1. The type of coal best adapted and its cost and freight per ton.
2. Sufficient water supply.
3. Cost of electric energy.
4. Sufficiently large unit with 25% over-capacity and the ability to increase the units if plant increase warrants it.
5. Good equipment for coal handling.
6. To obtain the most modern and approved type of producer.
7. Due regard to the removal of soot and cinders.
8. Convenient form of sand-dampers to dampen off the blank ends of pipe.
9. Sufficiently large gas mains.
10. To locate as closely as possible to the point of consumption.

There are still more to be cited, but errors in judgment regarding the above items are disclosed most frequently after the investment has been made. Sometimes they are so grossly wrong that re-design is necessitated. This, of course, renders the gas plant a costly equipment.

The costs of two different sizes of plants, operating fairly close to capacity and supplying gas to continuous glass tank furnaces, are tabulated here.

The analysis of operating cost figures for the two raw gas producer plants of normal size is given so that a com-

OPERATING COSTS OF TWO GAS PRODUCER PLANTS

Cost of Coal

Plant A (4 Producers in Service)				Plant B (2 Producers in Service)		
$ 761.00			Coal gasified	$ 219.00		
39.00			Coal consumed in boilers	31.00		
800.00			Total	250.00		

Cost of Operation

Plant A	Cost per Ton	% Cost		Plant B	Cost per Ton	% Cost
$ 52.50	0.0656	1.8	Labor (coal handling)	$ 22.50	0.0900	1.6
256.00	0.3200	9.1	Labor (operators, helpers, firemen)	236.45	0.9458	17.0
20.00	0.0250	0.7	Labor (repair)	20.00	0.0800	1.5
25.00	0.0312	0.9	Electric current	20.00	0.0800	1.5
14.00	0.0175	0.4	Water	10.00	0.0400	0.7
50.00	0.0625	1.7	Supplies (repair parts, etc.)	50.00	0.2000	3.5
775.09	0.9688	27.2	Overhead (depreciation)	471.71	1.8868	33.8
1,392.70	1.7403	49.0	Coal	413.05	1.6520	29.7
256.54	0.3207	9.2	Freight	148.72	0.5948	10.7
$2,841.83	3.5522	100.0	Total cost for average week	$1,392.43	5.5694	100.0

Industrial Management, April, 1926.

parison with other gaseous fuels may be obtained. The costs of operation and maintenance are largely dependent upon the scale of labor wage, cost of coal, capacity of operation and convenience of methods, items which apply to any producer plant.

Both are operating with good producer efficiency by common practice, but from the cost standpoint there are items which tend to show to what extent the equipment proves its economy.

Assuming that the plant has proper supervision for good gas making results, the first thing to be noted is the amount of coal gasified in each. It is like any other industrial operation wherein mass production tends to cheapen the product. The coal consumption is more or less a measure of the gas output, which is qualified by the kind of coal and operation. The gas made from a ton of coal may be estimated at:

1 lb. $\times$ 65 (gas in 1 lb. of coal) $\times$ 2,000 = 130,000 cu. ft.

In the raw gas unit (bituminous coal) a figure of 150 B.t.u. per cu. ft. would be fair, so that

130,000 $\times$ 150 = 19,500,000 B.t.u. per ton of coal.

The efficiency, then, becomes (if coal is 13,500 B.t.u. per lb.)

$$\frac{19{,}500{,}000}{13{,}500 \times 2{,}000} = 72.2 \text{ per cent, the operating efficiency}$$

at the producer.

However, it is essential that for a gas line of about 200 feet, a loss of approximately 10 per cent be taken. The efficiency resulting at the point of consumption will become 62.2 per cent. The reason for locating near the heating unit is evident from this line loss. Line losses in other forms of power transmission are similarly considered.

Two other items for comparison between plants A and B are the labor for inside operation (operators, helpers and firemen) and the overhead and depreciation. The labor is very much the same for both plants since up to four units of modern type there is needed an operator, helper and fireman for each of the eight hour shifts. The coal handling labor has sufficient time to assist in repair work and general labor in and around the plant. The percentage column of labor shows all this cost distribution per ton of coal consumed. As for the overhead—depreciation which is in proportion to the total investment will be lessened per ton of coal by a maximum gasification. These two items then illustrate the point to be brought out; that the equipment must be designed for sufficient gas but not burdened with a maximum labor cost and too great an initial investment, if this source of gas supply is desired.

To approximate the cost of this gas from the two plants, A and B, on a 1,000,000 B.t.u. basis, as delivered at the heating units, we have from Plant A:

Assuming boiler efficiency is 60 per cent:

$$\frac{2841.83}{761 + (39 \times .60) \times \frac{19{,}500{,}000}{1{,}000{,}000}} = 18.5 \text{ cents per}$$

1,000,000 B.t.u.

And for Plant B the cost per 1,000,000 B.t.u. is 30.1 cents.

There are many mechanical difficulties in producer operation that increase the cost of the resulting product if they are not properly provided for in the original design. An important one is the removal of soot which is an undesirable substance to handle due to its nature. One method, as applied at Plant B is a sewer using nothing but waste water, hence very economical in itself. To dispose of soot by this method requires no extra labor, cuts down the yard dirt and frees the men of a dirty tedious job. At Plant A, it is done by dumping on the ground and wheeling away. The result is the whole factory becomes continually tracked up with it and the townspeople complain. A further difficulty lies in inconvenient sand-dampers which warp and bulge, causing gas leakages and trouble in drawing on days of blowing out. However, there has recently come on the market a very well adapted form of damper.

All gas lines should be well equipped with dust legs, doing away with as many horizontal stretches as possible. By this means, the soot can not collect and cut off the gas flow. This is really a vital matter, since it causes constant trouble with the gas supply.

Operation labor inside of the producer plant is a perplexing one from the standpoint of wages and type of men required. Fundamentally, it is wrong to gather up from around the whole plant men of the laboring class who are unfit for any other type of work and turn them loose in the manufacturing of gas. From good, sound experience, the proper method is to hire men of ordinary intelligence, but with some initiative and an ability for mechanical things. Teach them their duties and outline their routine tasks thoroughly, seeing that these are faithfully performed, for herein lies the success of many a gas plant.

Next in order, are the helpers, who with similar duties, are nothing more than understudies to the operators. They should, in time, be able to perform the functions of an operator when needed. The boiler men must be reliable and of ordinary capacity who can appreciate the full responsibilities of their work. Over this unit of organization there should be placed a foreman or semi-technical man worthy of his position. Nothing is so discouraging as a set of producers causing all kinds of troubles. With these sundry troubles, one is further ahead if one pays the price at the beginning for a foreman who has made a study of the process, and is in every way like the man who runs the power house or the central station.

The operator is the next highest in pay to the foreman and therefore held accountable for his particular shift. Boiler men, whose duties keep them in place at all times and require constant watchfulness, come next in the order of pay. While the helpers form the bottom of the list, they are always in chance of one step upward.

The pay of the coal handling men is the same as the boiler men. They, too, have some responsibility and a great deal of equipment to keep in repair. Should they slight their work and be behind in the coal supply, a heavy breakdown may result which causes a total shut-down. In considering, from the description given, the types of men actually needed, their unit of pay may well be scaled according to the local standard of living.

Can Glass Molds Be Coated With Chromium?

By Charles H. Proctor

Chromium is at the present time of great interest to the electro-plating industry because of its presumably distinct advantages, viz: great hardness as a rust resisting factor when applied to articles made from iron and steel, and as a non-oxidizing factor. Chromium deposits should remain with their original lustre almost indefinitely. These properties claimed for chromium have proven of great interest to other industries as well as the metal fabricating industry, including the glass and rubber industries which use metal molds of great variety in the fabrication of glass and rubber products. The advantages of chromium as seen by these industries are: first, extreme hardness; second, non-corroding surfaces and third, non-oxidation, the surface of the mold remaining constant.

These qualities would prove chromium to be a splendid material for coating glass molds with an electro deposit if the deposition of chromium were strictly commercialized, but unfortunately it is not. Furthermore, so far as coating glass molds is concerned to give them extreme hardness and greater wearing qualities the high temperatures used in glass manufacture might render the deposit of metallic chromium extremely soft and therefore of no great intrinsic value. This is proven to some extent by George M. Enos in his paper entitled "Notes on Plating of Chromium upon Steel" presented at the forty-eighth general meeting of the American Electrochemical Society held at Chattanooga, Tenn., September 24, 1925. This paper should be of interest and also instructive to those glass manufacturers who are interested in the chromium plating of glass molds.

This subject should be taken up by the glass industry in general in an effort to prove whether chromium has any distinct value; test chromium plated molds against uncoated molds and decide the value of the process. Two firms at least are now exploiting chromium or chromium alloy deposits, for various purposes, but the cost of deposition is very high under present conditions.

The chromium plating solution developed and experimented with by G. J. Sargent (see *Transactions, American Electrochemical Society*, Vol. 37, p. 479, 1920) is still the basic commercial formula for plating solutions and is now being experimented with by a number of metal fabricating firms. This solution consists of:

Water	1 liter
Chromic acid	245 grams
Chromic sulphate	3 grams
Concentrated sulphuric acid	5 cc.

Enos mentions that he used with this solution anodes of lead (chromium anodes do not reduce in present chromium solutions). He further mentions that a current density of 350 amperes per square foot of surface is required to produce a uniform deposit. The temperature of the solution 24° C. or 75° F. and the voltage may range from 4 to 12.

A chromium solution at present being operated by a large automobile firm in the middle west with excellent results is essentially Sargent's solution with the elimination of the concentrated sulphuric acid and a similar addition of boracic acid or approximately one and a half grams per liter. This solution approximates the following:

Water	1 liter
Chromic acid	200 grams
Chromic sulphate	5 grams
Boracic acid	1.5 grams

Steel anodes are used. In a steel containing-tank for solution the anodes are so arranged in permanent positive current contact that they can be readily adjusted to the cathode near or far as may be found desirable.

The manipulation of this type of chromium solution is identical with Sargent's solution.

The Bureau of Standards, Washington, D. C., make use of the following chromium solution for the coating of printing plates:

Water	1 litre
Chromic acid	250 grams
Chromic sulphate	3 grams
Chromic carbonate	7 grams

Anodes for this solution should be of heavy sheet lead and they should be so arranged so as to entirely surround the molds or articles to be plated. The current and temperature is as given for the Sargent solution.

Unfortunately chromium solutions do not possess the "throwing power" of many commercial electro-plating solutions and it is thus difficult to chromium-plate deep depressions uniformly with any appreciable thickness of metal. This would mean a lack of uniformity of the wearing surface of a mold. Later developments may, however, overcome this physical defect in uniformity of deposition. Naturally such results can only be anticipated from a more perfect electrolyte that will have greater and more uniform throwing power.

The rubber industry has already experimented with chromium to some extent for plating molds, both in the production of automobile tires and mechanical rubber goods, with promising results. It should be borne in mind when considering chromium-plated molds for glass that there is a great difference between vulcanizing rubber and the temperature of molten glass.

In both cases the deposit of chromium on the mold must be absolutely adherent. This can only result from a perfectly clean mold free from oxidization, etc. The methods used by the electro plater must be closely adhered to if good results are to be produced. Any modern work on electro-plating such as Langbein's "Electro Deposition of Metals" (Eighth Edition) or "Electro Plating and Electro Forming," by Blum and Hogaboom, will give information in detail covering electro-plating methods.

Chromium plating for molds is worthy of consideration by the glass industry because progress can only be made in any industry through experimentation and the application of good sound theory applied in a practical way. The deposition of chromium has passed the experimental stage so it is up to the glass trade to determine whether the process has any real value for the industry.

The Laboratory

Technology and Valuation of Lead Oxides

Lead has been used as a constituent of glass for hundreds of years. It is one of the seven original glass making elements; silicon, oxygen, calcium, aluminum, potassium, sodium and lead. Lead may be added to the batch in the form of litharge, PbO, the yellow oxide of lead, or, more frequently, as minium, Pb_3O_4, the red lead oxide.

Litharge is lead monoxide. It is made by oxidizing metallic lead at a high temperature in rotating cast iron drums, heated by an external fire. The drums have shelves or ribs inside, which pick up the molten lead and cause it to fall in thin films through a current of air, drawn in by a fan.

Red lead is lead tetroxide. It is made by the direct oxidation of metallic lead at a temperature not exceeding 450° C. At too high a temperature, the red lead originally formed is reduced to litharge. The action is reversible, depending on the temperature:

$6\ PbO + O_2 = 2\ Pb_3O_4$ (below 450° C.)
$2\ Pb_3O_4 = 6\ PbO + O_2$ (above 450° C.)

As fast as a layer of oxide is formed, it is pushed to the back of the hearth. Finally the unoxidized lead is allowed to run off and the yellow colored oxide, called massicot is raked out and cooled. The material is ground and is then ready for the second stage of the process, in which it is heated in a reverberatory furnace with access of air. The mass is stirred frequently to assist the absorption of oxygen.

Chemically, red lead is regarded as a mixture of lead monoxide and lead peroxide ($2\ PbO + PbO_2$). When treated with dilute nitric acide the lead monoxide dissolves, leaving the peroxide behind as a dark colored powder.

Properties of Lead Glasses

When calcium is substituted by lead, either partially or entirely, the density and the rafractive index are increased, proportionate to the amount of lead added. The brilliance of lead glass makes it suitable for table ware and for cut glass. On account of the increased refractive index, lead glass is used to produce certain kinds of optical glass.

Litharge has the advantage over red lead of being less expensive. If sufficiently pure, it is quite suitable for glass making. However, litharge sometimes contains metallic lead, which has remained unoxidized. Glass made with such litharge shows a dark color. Red lead, being submitted to more prolonged heating, is usually free from metal.

Red lead, upon heating in the glass furnace, gives off oxygen, beginning at 450° C. and quite freely at 550° C. At the melting temperature, the oxygen has all been given off. Therefore it is difficult to see how red lead can prevent reduction to metallic lead on account of its greater oxygen content, as is frequently claimed.

[1] Guide du Verrier, p. 535.

The purity of the lead oxide used, whether as litharge or as red lead, is of paramount importance. Lead oxide is used in high priced glass ware and a small amount of impurity may render a pot of glass worthless. Since lead ores are often associated with minerals containing silver, bismuth, copper, cadmium, arsenic, antimony, tin, iron, cobalt, nickel, manganese and zinc, all of these metals may occur in the lead as impurities, in very small or in larger quantities. Some of these metals are harmless, such as zinc and arsenic. Small amounts of copper give a bluish green color to the glass, which cannot be corrected by any decolorizer known at the present time. Bismuth and antimony, while less harmful than copper, affect the brilliance of the glass. It is clear that several of the impurities mentioned have no effect whatever on opal glass, or colored crystal glass and the requirements of lead oxide, used to produce such glasses are less severe than when clear transparent glass is made.

Iron must be absent, or if present should not exceed 0.1 per cent. Sand, clay, tin oxide, lead sulphate and barium sulphate have been found occasionally in lead oxide. Manganese, when present in small quantities is considered an advantage, since it acts as a decolorizer. According to Bontemps,[1] lead oxide containing manganese gives a better decolorization than when the manganese is purposely added to the batch. For this reason French glass makers value it highly, and mix it with lead oxide, free from manganese, to produce the desired decolorizing effect.

Analysis of Lead Oxide

DISTINCTION BETWEEN LITHARGE AND RED LEAD. Usually the difference in color is sufficient indication as to whether a sample of lead oxide is litharge (yellow) or minium (red). Litharge is completely soluble in nitric acid. Hydrochloric acid attacks litharge, forming insoluble white lead chloride. Red lead is only partly soluble in nitric acid, one-third of the material remaining insoluble as lead peroxide. Red lead is attacked by hydrochloric acid, with the formation of free chlorine gas.

QUALITATIVE ANALYSIS. Solution of red lead in nitric acid. To effect solution of red lead in nitric acid, the material must be heated to above 450° C., for some time, until it is completely converted to litharge, which, as stated before, is soluble. Solution without previous heating may be obtained by treating the red lead with dilute nitric acid to which a reducing agent is added, preferably oxalic acid, or sugar.

If an insoluble residue remains, it may be sand, clay, tin oxide, lead sulphate or barium sulphate. To the filtrate of the residue sulphuric acid is added in slight excess. This precipitates the lead as lead sulphate. It is allowed to settle and the clear liquid poured through a filter. If on addition of ammonia to a portion of this liquid a blue color appears, copper is present. Iron is tested for by adding potassium thiocyanate solution, which will give a red color when a trace of iron is present.

Quantitative Analysis

For a complete description of the methods used for the quantitative analysis of red lead, litharge or metallic lead, the methods worked out by the National Lead Company may be used.[2] If only copper and iron are present, the following procedure is recommended.

COPPER. Dissolve a two gram sample in nitric acid, add sulphuric acid in slight excess and evaporate to fumes of sulphur trioxide to remove all nitric acid. Add water and alcohol, filter off lead sulphate and wash with 50% alcohol.

Heat until the alcohol is removed, put an aluminum ring (which must be free from copper) in the solution, and boil until the copper in the sample is precipitated. Filter, wash with 2 per cent sulphuric acid, saturated with hydrogen sulphide gas, dissolve the copper in hot, dilute nitric acid, make slightly ammoniacal and then add nitric acid, drop by drop, until slightly acid. Add 5 cc. sulphuric acid (1:1) and electrolize the solution, using a current of 3 amperes.

For the determination of iron, treat two grams as above, to remove the lead. Add ammonia in excess, to precipitate the iron, which can be subsequently determined by the colorimetric thiocyanate procedure or by the potassium iodide method.

[2] Scott. Standard Methods of Chemical Analysis, 3rd Ed., Vol. 1, pp. 286-290.

The Action of Molten Glass on Refractories*

The life of a glass furnace, especially a tank furnace, is dependent on the ability of the furnace materials to resist pyrochemical influences. The complaint is heard frequently that the refractory materials do not fully measure up to the requirements. It is not taken into account that the composition of the batch and the fluxes used are especially harmful to the furnace materials and may cause premature destruction of the tank blocks. The times and general conditions make it desirable to the majority of glass factories to use the less costly salt cake instead of the expensive soda ash. Not only in bottle glass work but also in window and plate glass factories salt cake is used almost exclusively.[1] It is well known that a salt cake batch attacks tank blocks very forcibly, especially if insufficient coal is added for reducing the sulphate. In that case glass gall appears on the surface of the molten glass.

In order to reduce the cost of the batch and to obtain a good quality of glass the batch is made as hard as possible, and a comparatively high furnace temperature is necessary. The requirements made of refractory blocks, therefore, are twofold:

1. Resistance against chemical action of the molten glass.
2. Resistance against high temperatures.

It goes without saying that the natural wear and tear, increasing with time, is not being considered.

An increase in the life of an oven can only be obtained if all requirements have been fulfilled. One of them is that the factory producing the refractory blocks should know the use and the requirements which should be met. Many glass factories neglect to mention the composition of the glass when orders are given for materials that are constantly exposed to molten glass. This is the reason why, in spite of the demand for "highly refractory materials" unsuitable ware is delivered, without the seller being to blame. When ordering the following rule should always be observed: The composition of the tank blocks must in every case be in relation to the composition of the glass. If this is not the case, that is, if the amount of silica in the glass is considerably higher than the silica content of the tank blocks, the latter will be strongly attacked. This attack will be aided by the high temperature which is necessary in a glass of high viscosity. Experience has shown that refractory clays begin to soften at a temperature of about 1400° C., and in this condition the chemical resistance becomes greatly reduced. The solution of the tank blocks causes a supersaturation of the molten glass with alumina, resulting in glass defects such as cords, waves and stones, which render the glass unfit for use.

The chemical attack of the molten glass on the tank blocks is especially noticeable after the first melting in a new or repaired tank. In order to reduce this injurious action to a minimum, it is advisable to glaze the new tank blocks. To do this the blocks are covered with powdered cullet. When the melting temperature is reached the blocks are covered with a layer of glass, which forms a protective covering against the destroying influence of the molten batch.

In tanks which are divided by an inside wall, in which glasses of different composition and color are melted, this procedure is especially recommended. Although cooling tubes protect the blocks from overheating, the attack of the molten glass cannot be avoided.

This protective covering is not considered of much importance by some glass makers on account of the constant movement of the molten glass towards the working end. It should be pointed out, however, that these currents run especially in the hotter part of the tank, in the direction of the flames. The course of the melting operation and the flame temperature are of influence on these currents and consequently on the glass. The refractory material should possess the lowest possible heat conductivity. This is not in accord with the desired homogeneity of the block, for the more compact the material, the greater the conduction of the heat. The observation can be made that the glass which is in direct contact with the blocks becomes viscous due to cooling. This makes the presence of currents alongside the inside walls unlikely. The objection that the currents in the glass render the glazing of tank blocks useless can therefore not be considered justified.

The upper tank blocks are especially exposed to the corrosive action of the glass surface which is kept practically at the same level. For this reason these blocks must be replaced often. "Hot repairs" are made by lowering the surface of the glass, while the furnace is kept hot. A preliminary heating of the new tank blocks is recommended.

* *Keramische Rundschau*, 33 (1925) 463-464.

[1] Reference is made of course to conditions in Germany.—EDITOR.

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Henry Ford, Glass Manufacturer

There are books that have changed the course of history of nations, because they were the embodiment of the thoughts and passions of multitudes. "Today and Tomorrow," written by Henry Ford in collaboration with Samuel Crowther, may prove to be such a book in the industrial history of America. His ideals and policies, as outlined in a few hundred pages may be regarded as the most effective antidote against the vagaries of Karl Marx, *et al*, that has ever been administered.

The principles expressed are nothing new or revolutionary. Many of them have been applied in every successful enterprise. But it has remained for Henry Ford to combine these principles, and to follow them up to their ultimate and logical conclusion. His thoughts have materialized before they were written down. The economists and philosophers have written volumes, promising Utopia to the nation that would follow their precepts. As a result all they have to show for it is Soviet Russia. Henry Ford can point to the fact that three million people are getting their living from the development of his ideas.

How the Ford industries have grown into the greatest industrial organization the world has ever known, how it is still growing from year to year and what the guiding principles are, is decidedly a matter of interest to every one concerned with industry. By going back to the primary sources of most of the materials used in the building of an automobile, it was necessary to go in to about forty-five different lines of production, some entirely new, and some entirely different from the established methods of manufacture. To the glass industry the most striking achievement is undoubtedly the manufacture of plate glass by an automatic and continuous process.

The importance of the automobile to the glass industry is best demonstrated by the fact that the Ford industries use about one quarter of the plate glass produced in the United States. It is due to the inexpensive and simple "flivver" that other makes of automobiles have been lowered in price so as to be available to a vast number of people. This in turn has increased the demand for plate glass to the present enormous consumption.

When the Allegheny Plate Glass Company was bought by the Ford interests it was making six million square feet of glass a year. With only a small amount of additional machinery and with the old staff of men, the production was raised to eight million square feet. No fundamental changes were made in the method of manufacture. Increased efficiency, better organization and higher wages were responsible for the greater output.

The new continuous process, developed at Highland Park, and applied on a large scale at the River Rouge plant, was worked out by men who had no previous knowledge of glass manufacture. To quote verbally: "They had not had a chance to get on really familiar terms with the impossible." The River Rouge plant, although occupying only about one-half of the space of the Glassmere plant, has nearly double its production, and employs only about one-third as many men. Present glass making facilities are not sufficient to care for the needs, but already a saving of three million dol-

lars a year is obtained on the glass made, as compared with what it would cost to buy it outside of the organization. This is the best explanation of the apparent paradox of low cost and high wages.

That American industry in general realizes the truth of these principles, and applies them on a large scale is shown by the unparalleled increase in the manufacturing efficiency since pre-war days. This increase is easily the most phenomenal economic development of the twentieth century. It has resulted in a growth in volume of production of 33 per cent per wa earner as compared with 1914, and required 25 per cent labor, 13 per cent less power, 17 per cent less management sonnel per unit of production and 7 per cent less actual wo ing time per man.

American try is applying the principles enunciated by Henry Fo out nowhere have they been as thoroughly tested and as sistently applied as in the Ford industries. His message to manufacturers will have a profound effect on future industrial development in this country and wherever there is progress in manufacturing.

Technical Consultation Service

Method of Boring Holes in Glass

QUESTION 97—Please inform us as to what is the best method of boring holes in glass.

ANSWER: The machinery required is a drill press (ordinary type). Into the chuck should be inserted a piece of steel tubing the diameter of which is the same as the hole desired in the glass dish. The free end of the tubing is slotted in two places, 180 degrees apart on the circumference to a depth of ½ inch and about 1/16 inch wide.

The drill should rotate about 1200 revolutions a minute. There is less breakage at the high speed.

The drill is centered on the spot where the hole is desired. A rubber washer about 1½ inch wide is placed on the glass, acting as a little cup. Into this is placed a mixture of water and carborundum (anywhere from 70 to 100 grit). Then the drill is started and is lowered to touch the glass. The drill should be raised from time to time, and water added if required. As soon as the drill goes through the glass, it should be lifted.

Methods of Analysis

QUESTION 98 (From Holland).—We shall thank you very much to let us know where we can get Hillebrand's "Rock Analysis," U. S. G. S., Bulletin No. 700, referred to in Volume 7, No. 2, page 37, of your journal.

Are there analysis instructions (standardized instructions if possible) for analyzing cryolite, feldspar, fluorspar and if so at what price can these be had?

ANSWER.—Bulletin No. 700 of the United States Geological Survey can be obtained from the Superintendent of Documents, Washington, D. C. Since it would be quite a lot of bother to you to obtain this book we shall be very glad to take care of the transaction and forward a copy to you.

We feel quite sure that you will find this publication of great value to you in your work. It is a book which should be in every chemists' library, especially those interested in silicates.

With regard to methods of analysis of cryolite, fluorspar and feldspar, we refer you to THIS JOURNAL, Nos. 5 and 6, of the current year. The method for the determination of fluorine in cryolite can also be used for fluorspar.

These methods of analysis have not been standardized. At the meeting of the Glass Division of the American Ceramic Society, held in Atlanta, Georgia, last February, the matter of standardization of analytical methods was discussed, but no action was taken. We believe, however, that ultimately the methods of glass analysis, and of the various raw materials will be standardized, as has already been done by the United States Steel Corporation for their raw materials and products.—J. B. K.

Literature on Enameled Glass and Optical Glass

QUESTION 99—Do you know of any literature on the subject of enameled glass, i.e., fired enamels on glass surfaces? Please give the names of books on the manufacture of optical glass.

ANSWER. With regard to enameled glass, designs are painted on the glass surface with a brush and dried. The glass is then placed in a muffle furnace and brought to a dull red heat for a short time. The colors are thus burnt into the glass surface, and cannot be removed by scratching. The colors are metallic oxides or salts, mixed with a suitable flux. As a medium of application a good varnish or lacquer is required. With regard to the literature on the subject, there is a reference to it in "Textbook of Glass Technology," by Hodkin & Cousen, p. 522, giving a number of formulas for the preparation of the chief coloring agents used. An excellent description of the methods of enameling is found in "Handbuch der Glasfabrikation" (in German) by Dr. E. Tscheuschner, Chapter 19, pp. 599-628. Another good description occurs in "Guide Du Verrier" (in French) by Bontemps, Book VII, Chapter I, pp. 722-747.

With regard to optical glass, probably the best outline of the methods of manufacture can be found in the book entitled "The Manufacture of Optical Glass and of Optical Systems, A War Time Problem. Ordnance Department Document No. 2037, by Lieut. Col. F. E. Wright, Ordnance Reserve Corps, Government Printing Office, Washington, D. C. This book can be bought from the Superintendent of Documents, Washington, D. C. An important article on the subject by Dr. C. J. Peddle has appeared in the *Transactions of the Optical Society* (England), Vol. XXIII (1921-1922), No. 2. Another article of importance (in the German language) has appeared in *Die Glashuette*, 1921, entitled "Herstellung und Eigenschaften des Optischen Glases," by Dr. F. Weidert, Director of the Optical Works C. P. Goertz, Berlin-Friedenau. From the same author an article has appeared in *Zeitschrift des Vereins Deutscher Ingenieure*, 1923, No. 8, entitled "Die Arbeitsverfahren des Optikers und seine Hilfsmittel."

Industrial Publications

MacRae's and Hendricks Commercial Register. The first consolidated edition of the two well known buying guides formerly published separately and used extensively by many buyers of all sorts of materials. This book combines the most desirable features of MacRae's Blue Book and Hendricks Register, whose service record in the interests of national industry totals 49 years!

At the front of the book a section of 278 pages is filled with manufacturers' names and addresses and, what is a very valuable feature, the addresses of their local distributors. A 72-page index of classifications and cross references covering manufactured products of almost every kind follows. Then comes the Classified Material Section occupying about 1,700 pages with over 12,000 products listed in convenient alphabetical arrangement from Abrasives to Zobos for quick finding and with the names of the leading manufacturers listed below them.

At the back of the book the Trade Name Section fills 223 pages with manufacturers' names and addresses arranged alphabetically. This book contains 2,225 pages, is strongly bound in stiff covers and measures 8½ x 11 x 3½ inches. It is published by MacRae Blue Book Company, 18 East Huron street, Chicago, Ill. Price $12.00, express prepaid.

For the purchaser of materials in large quantities a reliable buyers' guide of this type is practically indispensable and the same holds true, in a lesser but substantial degree, of the small buyer who is enabled to save both time in locating sources of supply and money when making his purchases. From its own experience the GLASS INDUSTRY can testify that it is a very useful book.

H-K Optical Pyrometer. Bulletin 293. A twelve-page folder describing the Holborn-Kurlbaum optical pyrometer, issued by the Bacharach Industrial Instrument Company, 7000 Bennett street, Pittsburgh, Pa. For use in glass tanks this pyrometer is sighted into a closed end tube inserted into the bath through a diagonal hole cut in the wall just above the surface of the glass.

The National Physical Laboratory's Work on Glass

Annual Report for 1925

The annual report for the year 1925 of the National Physical Laboratory, which functions in England in much the same way as does the Bureau of Standards in the United States, was recently issued in book form. It is a paper-covered volume of 242 pages, 8 x 10½ inches in size and may be obtained from H. M. Stationery Office, London, at 8 shillings 6 pence, net.

The report records the activities of the Laboratory, the Physics, Electricity, Metrology, Engineering, Metallurgy, and other departments.

Glass Research

Work for the Glass Research Association having ceased, owing to the dissolution of the association, research on glass has been restricted to a continuation of the measurement of viscosities at high temperatures. This has been carried on with a view to throwing further light on the fundamental constitution of glass. Papers summarizing the results of earlier measurements have been published, one in the *Proceedings of the Royal Society* by V. H. Stott, E. C. Irvine and D. Turner, and another in the *Journal of the Society of Glass Technology* by V. H. Stott.

The method of measuring the viscosity of glass at high temperatures, by determining the amount of glass which adheres to a fine platinum wire immersed in the molten glass and withdrawn at a known constant velocity, has been further developed, and has now furnished successful results. The apparatus referred to in last year's Report has been completed and has now been at work for a considerable period. The platinum-wound resistance furnace has worked continuously and successfully, only one repair having so far been necessary. The method has been found to yield very concordant results, and, since the glass is in contact only with platinum, it is possible to repeat determinations a large number of times on the same glass, which can be subjected to any desired heat treatment without risk of contamination by the solution of material from refractory containers. The results so far obtained have produced interesting data which show that there is no appreciable variation of viscosity as a result either of time of heating, or of repeated cooling to room temperature, provided that the glass has first been rendered homogeneous by stirring during the first melting. This result has been confirmed in a variety of ways by subjecting the glass to different kinds of treatment, and suggests that the ideas indicated in last year's report concerning the possibility of gradual changes in glass are in reality without foundation. These results, if fully confirmed by further work on other glasses, are of great importance, both theoretically and practically. From the former point of view it would appear that homogeneous glass at high temperatures is a definite material, having properties dependent only on chemical composition. It should therefore be possible to compare viscosity measurements made by different methods without reservation concerning the state of the glass, provided that care is taken to secure mechanical homogeneity in the first place. From the practical point of view it would further seem that various obscure but frequently occurring phenomena cannot be explained by assuming that the properties of the glass depend upon its past history. The present results suggest that investigation of the degree of heterogeneity of commercial glass is of much greater practical importance than has hitherto been supposed, and that the effects of small changes of chemical composition may be much more marked than might be anticipated. The apparatus and method have now been established, with a definite and satisfactory technique, in such a way that further measurements can be made with comparative ease and rapidity, and it is proposed to extend them to a variety of glasses, both commercial and specially prepared for the purpose.

With regard to the production for optical glass purposes of special pots of high resistance to solution by glass, as mentioned in previous reports, larger examples have now been made successfully of the "mullite" mixture, but an opportunity for testing them has not yet occurred.

Refractories

In consequence of the restriction of glass research to investigations relating to the fundamental properties and constitution of glass, the activities of the Department with regard to refractories have been concentrated upon the study and production of special materials for metallurgical research.

General Chemistry

The Laboratory has now in use several kinds of English chemical glassware, which are proving highly satisfactory. It is particularly satisfactory to find that check tests, made to ascertain the influence, if any, of glass containers on analytical results, closely confirm the high values for the resistance of these glasses obtained by the ordinary standard tests quoted in the published reports. For example, in a recent analysis of some experimentally prepared glass of high purity, unexpectedly high figures for magnesia content were obtained. After exhaustive examination of all the chemicals employed, this impurity was eventually traced to the nitric acid. During the course of the investigation, however, residues obtained by evaporation of the acid in platinum gave identical results with those obtained in glass vessels. This proves that the attack on the glass is negligible. In this connection it must be pointed out that the purity of many reagents now supplied for analytical work appears to be capable of considerable improvement. Difficulty with the reagents has arisen on several occasions during the year, both in glass analysis and in analysis of very pure metals and alloys.

Colored Glasses for Railway Signals

Very little further work has been required in connection with railway signals during the past year. A number of pressed colored lenses have been tested for the Physics Co-ordinating Research Board and also for individual railway companies. The measurement and specification of the color and other properties of a pressed lens, in which the color of the material varies over a wide range owing to the variation of thickness from point to point of the aperture, involve difficulties which are not encountered in dealing with colored windows, and further consideration will have to be given to the basis of standardization in the case of colored lenses if these are to come into general use.

Colorimetric measurements have been carried out on the Board of Trade standard red and green glasses for checking the color screens in ships' navigation lanterns, the original specifications for which are on a photometric rather than a colorimetric basis. The red glasses give saturated colors and present no difficulty. The green glasses, however, give unsaturated colors in the region of the color field in which the existing data for colorimetric standardization are unsatisfactory. It was accordingly necessary in the case of these glasses not merely to give the specification in terms of hue and saturation, but also to define the method by which these quantities were obtained. The colorimetric specification of the green glasses should therefore be reinvestigated when improved data are available.

Accuracy of Optical Settings

This work, which had been in abeyance for some years, has been resumed.

Standard Colored Glasses for Railway Signals

As mentioned in the report for 1924, the Board of Trade standard glasses for ships' navigation lights have also been adopted for railway purposes, and the Laboratory has been asked to undertake the verification of standard glasses for use by the railway authorities. A number of glasses have been received and tested for this purpose.

Tests on Glass Volumetric Apparatus

The quantity of apparatus tested during the past year was about 25 per cent. greater than the quantity tested in the preceding year.

The adoption of the "millilitre," instead of the "cubic centimetre," as the unit of volume for volumetric glassware, was strongly recommended in 1924. Practically the whole of the volumetric glassware submitted to the Laboratory for test during 1925 was graduated in terms of the millilitre and marked "ml."

Glass Research

Further research on glass will be confined mainly to additional measurements of viscosity at high temperatures. The comparatively rapid methods that have now been developed will be utilized for the study of a number of glasses over a wide range of temperature, and for the investigation of certain anomalies that have been detected in the temperature-viscosity relations.

Bottles for the Sale of Lubricating Oil

A Paper Presented at the Nineteenth National Conference on Weights and Measures

By Howard R. Estes*

In the early days of the automobile, and until very recently, metal meausures alone were used in the measurement and sale of motor oil.

Measures made of metal have the unfortunate property of becoming dented, the amount of such denting varying with the sturdiness of construction and the material used in the measure. A dented measure is not an accurate measure and thus becomes worthless as a measuring device.

Then again, it takes a trained juggler to fill a metal measure full of oil, transport it ten feet to a waiting motor car, and deliver it into the proper place without spilling more or less of this expensive necessity.

Because of this spilling performance, station attendants were prone to do one or the other or both of two things, namely, fail to properly fill the recepticle or, second, use a larger capacity measure for a smaller delivery, such as a two quart measure for a one quart delivery.

Both of these practices are wrong.

Those of us enforcing the weights and measures laws and regulations in Michigan feel that our far seeing State Commissioner has acted wisely in promulgating a regulation which prohibits this latter practice. The regulation is worded as follows:

"Cylinder Oil. Cylinder oil, when delivered, shall be in a standard liquid measure of the capacity purchased and the capacity of the measure shall be conspicuously, legibly and permanently indicated on the side of the measure. The indiscriminate use of receptacles of capacity differing in amount from the quantity purchased is prohibited."

Metal measures, expecially when exposed to dust and dirt easily become "gummy" and will not deliver the true capacity.

The use of "bottom exit" measures with a thumb flow control was introduced but the ease with which fraud could be perpetrated with such measures soon made them unpopular with weights and measures officials.

A need was felt for some other sort of device for dispensing oil which would have none of the faults of metal measures and yet would be economical and accurate.

It was only natural that glass containers would be used insomuch as glass had been used for liquids for many years.

It was my experience, and probably the experience of many other officials, to find the oil station men turning to the most convenient glass measure—the milk bottle. It satisfied the want nicely. It was a fairly accurate measure, it was easy to handle, it occupied little space and was very convenient to empty. But it wasn't long before Mrs. Housewife began to get dark colored milk in darkly stained milk bottles which milk didn't look as if it was colored with black from the Holstein cows' back and which, upon further investigation, tasted like Dad's garage smelled.

This resulted in the passage of local ordinance, state laws, etc., which provided that milk bottles should be used for milk only.

Next in line came the fruit jar. Because of the wide openings found on most fruit jars some device became necessary for directing the flow of oil from the bottle and from this need came the long metal spouts—first without a vent and as a latter addition the vent was provided.

The fruit jar measure, however, while being very convenient, offered an opening for the perpetration of fraud insomuch as the top half inch of the container was covered by a metal spout and therefore neither the buyer nor the seller knew if the correct quantity was being delivered.

The use of fruit jars with metal spouts as oil dispensers has not been entirely eliminated at this time and steps should be undertaken to put an end to the practice of sales by means of these devices.

From all of these objections on the part of weights and measures officers and from the well known fact that at least 95 per cent of our merchants are honest and want to deal correctly with their customers, and probably because of the well founded truth that the American people are never content until they have something better, came the present styles of oil dispensing bottles. To say that perfection has been reached would be an error but it can be truthfully said that great improvements have been made.

Errors in capacity have been discovered in these bottles and on one occasion it was necessary for a state department to destroy two complete carloads of bottles because they were short in measure over and above the tolerance permitted. It can be said, however, that a great improvement has been noticed in this connection recently.

A few of the important features of bottle measures might be taken up at this time. The manufacturers themselves have provided air vents on most all types of spouts used on bottles, thus insuring a minimum of time necessary to empty a bottle. If the time element ever was important that fact is brought out in the operation of a filling station. A motorist, out for pleasure and going nowhere in particular, will stew and fret over ten seconds delay in serving him. If these ten seconds can be saved by the oil dispensing attendant by means of a quickly draining bottle it means money in his pocket.

Bottles should be clear in color. While not a question of measure I believe that the use of stained or off-color glass should be discouraged so that the consumer may more clearly see the color and quality of the oil which he is buying.

It has been stated that unscrupulous dealers have strained used oil from motors and resold it as new oil. Clear glass containers would help to eliminate such a practice.

Spouts on bottles may later be made exceptionally long just as the old dry measure approached the appearance of a stovepipe before the practice was stopped. Long spouts might be used to cover up a short delivery caused by poor or hurried drainage.

Marks used for capacity indications should be definite and easily seen and of such a character as not to be confusing. No more than one indication should be permitted on a container.

Arrow indications are sometimes found on glass containers without any definite directions nearby, and the consumer may be led to believe the capacity mark was the arrow point, whereas the true capacity point was the ring above the arrow point.

The diameter of the neck of the bottle at the capacity mark influences very directly the percentage of error likely to occur in filling the bottles. It would seem that a narrow necked bottle is to be preferred to a wide necked bottle for this reason.

There also exists the very important question as to whether an oil container should be manufactured to **hold** the quantity or to **deliver** the quantity indicated on the measure. After having spent some little time observing the amount of oil left in quart containers after a reasonable amount of time had been used in draining these bottles I have reached the conclusion that oil bottles should be manufactured to **deliver** the amount indicated as the capacity.

It is indeed fortunate that there is a common meeting ground (this National Conference) on which manufacturers, consumers, dispensers and weights and measures officers may congregate to talk over questions of the importance of the one just mentioned and I sincerely hope that the opportunity may be grasped and that this question in particular may be decided in the near future.

The glass oil dispenser is here to stay for a long time and while the products sold through this medium are valued at only one-tenth the amount paid for motor fuel, the total amount involved justifies the utmost care in the selection of specifications and tolerances to cover the necessary measures involved.

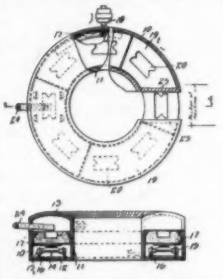
* City Sealer of Weights and Measures, Flint, Michigan.

Recent Patents

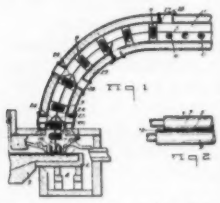
NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C. Price 10c each

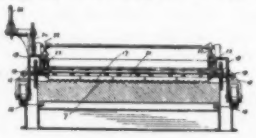
GLASS-MAKING MACHINE. U S. 1,591,831. July 6, 1926. Albert A. Icenhour, Detroit, Mich., assignor to himself, Benjamin F. Neumann, Emil C. Patzer and Wesley E. Garrison. Filed 11/8/22. Within the housing there is an endless conveyor, having trucks mounted on wheels running on an endless track. Conveyor is adapted to carry a series of pots. At one side there is provided a feeding means for molten glass. In some cases it may be desirable to feed a batch and melt it in the pot. By using small pots in a protecting housing, the glass that remains in the pot does not cool to an excessive extent and will merge into the next batch fed in when the pot again reaches charging position. For drawing the glass, a single cold bait is provided. A movable frame is positioned on the pot exposed by an opening in the housing. A pair of rockarms are each pivoted to the frame, the rockarms cause the frame to move to a horizontal position, with the sheet of glass ready for the lehr.



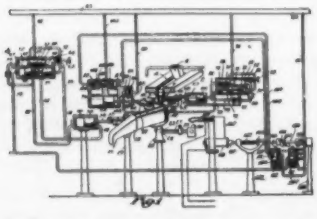
DRAWING SHEET GLASS. U. S. 1,592,444. July 13, 1926. Joseph P. Crowley, Toledo, O., assignor to the Libbey-Owens Sheet Glass Co. Filed 3/22/24. The process of drawing and flattening the sheet glass in the same vertical plane, then deflecting the continuous sheet after it has become substantially set without exceeding its limit of elasticity into a horizontal plane, and continuously annealing the sheet during the bending process and after it reaches the horizontal plane. The series of bending rollers are all enclosed by a curved shaft or housing, which maintains the sheet at the proper temperature and serves in fact as a portion of the annealing lehr.



PROCESS FOR MAKING CORRUGATED WIRE GLASS. U. S. 1,592,228. July 13, 1926. Arno Shuman, Philadelphia, Pa., assignor to Pennsylvania Wire Glass Co. Filed 2/11/26. The process of making wire glass which consists in rolling a plain sheet of glass with wire mesh embedded therein, and, while the interior portion of the sheet is sufficiently plastic by heat to permit twists of the mesh to stretch and while the exterior of sheet is sufficiently solid by cooling upon bending to retain its form, simultaneously corrugating said sheet and mesh in part by laying it upon a corrugated table and in part by pressing it between corrugated surfaces.

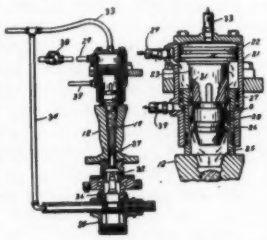


FEEDING MECHANISM FOR GLASS-MOLDING MACHINES. U. S. 1,592,253. July 13, 1926. Clyde A. Beeth, Rochester, N. Y. Filed 5/11/22. A feeding mechanism for glass molding machines comprising a spout rotatable about an upright axis to move the discharge end of the spout toward and from the molding machine, a weighing mechanism for delivering molten glass to said spout, and mechanism controlled by said weighing mechanism for effecting the movement of the spout about its axis.

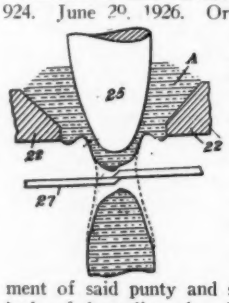


GLASS-MELTING CONTAINER. U. S. 1,592,336. July 13, 1926. James Bryce, Pittsburgh, Pa. Filed 1/30/23. The inventor has found that a ferrous alloy containing from 25 to 45% of chromium and from 73 to 53% of iron will resist appreciable oxidation when in contact with the substances entering into a glass batch, and while such elements and substances are melted to form molten glass. The alloy can be cast into the form of a pot or crucible or may be rolled into plates from which furnaces may be fabricated.

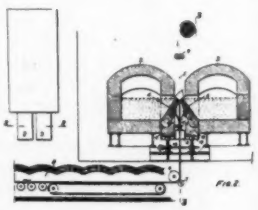
GLASS-FORMING MACHINE. U. S. 1,590,423. June 29, 1926. Albert N. Cramer, Toledo, O., assignor to Owens Bottle Co. Filed 5/9/24. By sufficiently reducing the cavity or bubble formed by blowing the blank in the blank mold, waviness or uneven distribution of the glass in the finished article can be practically eliminated. In order to effect such a result, the present invention provides a blowing head, constructed to close the upper end of the blank mold and supply air under pressure to compact the blank in the mold, in combination with a plug or head of a size and shape to enter the upper end of the blank mold cavity, which has necessarily been made large to admit the charge of glass, and thereby reduce the space left for expansion of the glass in the mold.



METHOD OF AND APPARATUS FOR FEEDING GLASS. U. S. 1,590,924. June 29, 1926. Orville A. Bridges, of Zanesville, O., assignor, by mesne assignments, to Hartford-Empire Company. Filed 11/25/18. The method of serving quotas of glass from the bottom orifice of a receptacle supplied with molten glass, which consists in permitting a body glass to flow and depend from said orifice, in penetrating the upper end of said depending body of glass by a punty descending from above through said orifice, in momentarily reversing the flow of glass from said orifice by the upward movement of said punty and simultaneously therewith in severing the body of depending glass below the point of said punty and lifting the remaining portion of glass up from severing means.

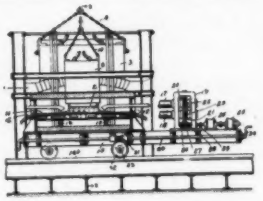


APPARATUS FOR MAKING WIRE GLASS. U. S. 1,592,180. July 13, 1926. Walter Cox and Arno Shuman, of Philadelphia, Pa., assignors to Pennsylvania Wire Glass Company. Filed 12/18/20. Apparatus for making wire glass comprising the combination of a glass tank furnace, confronting extensions communicating with the interior of the tank, opposed dams in the confronting portions of the extensions and over which the glass is required to flow, and means for continuously passing wire netting between the dams.



APPARATUS AND PROCESS FOR MAKING SHEET GLASS. U. S. 1,590,189. June 29, 1926. Frederick Gelstharp, Tarentum, Pa., assignor to Pittsburgh Plate Glass Co. Filed 10/7/24. The combination with a tank provided with an outlet, so as to permit the discharge therethrough of molten glass under the head pressure of the tank, a stationary spreading table in position to receive the molten glass from said outlet of a width much greater than that of said outlet, a sizing roll over the table intermediate the ends thereof, a pair of traction rolls in advance of the sizing roll for engaging the upper and lower sides of the sheet and pulling it over the surface of the table and beneath the sizing roll, and a lehr provided with means for carrying the glass therethrough.

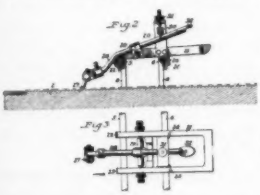
APPARATUS FOR MAKING SHEET GLASS. U. S. 1,590,820. June 29, 1926. Frederick Gelstharp, Tarentum, Pa., assignor to Pittsburgh Plate Glass Co. Filed 10/7/24. Principal objects are the provision of apparatus, wherein the contact of the molten glass with the clay work at the end of the tank is reduced to a minimum, thus reducing the contamination of the glass tending to cause string and ream to a minimum; and wherein the lengthening of any bubbles in the glass incident to the rolling and sizing action is reduced, so that the visibility of such bubbles in the finished product is made as slight as possible. Lateral spreading of the glass tends to widen the bubbles laterally and thus counteracts the tendency to lengthen them in the direction in which the surfaces of the rolls are moving, since the surface glass carrying the bubbles stiffens before reaching the rolls.



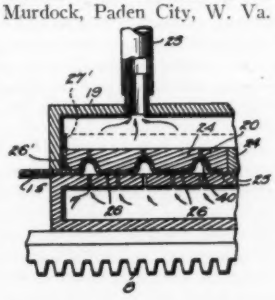
PROCESS OF AND APPARATUS FOR MAKING SHEET GLASS AND OTHER ARTICLES. U. S. 1,591,179. July 6, 1926. Hubert A. Myers, Toledo, O. Filed 7/26/20. Drawing sheet from a supply of molten glass, deflecting the sheet to change its course of travel, while maintaining therefor a perfectly level and highly polished surface, and supplying a fluid to support the sheet and keep it pliable at the point of deflection therein, in which said fluid is air preheated to prevent chilling of the glass.

METHOD OF LAYING GLASS SHEETS ON WORKABLES FOR GRINDING AND POLISHING. U. S. 1,589,787. June 22, 1926. John W. Butler, Chicago, Ill., assignor to United States Gypsum Co. Filed 9/14/23. Consists in applying a layer of plaster in a plastic state upon a flat table having a plurality of holes therethrough, in placing a plate of glass upon the surface of the plaster and allowing the layer to dry and set, adhering to the table and the under side of the glass, the holes being preferably evenly spaced to expose the plaster at intervals so it will dry and set uniformly.

GLASS-CUTTING APPARATUS. U. S. 1,589,910. June 22, 1926. John Waterloo, New Eagle, Pa., assignor to Window Glass Machine Co. Filed 10/28/22. The combination with a glass-cutting table, of a bridge mounted to span the table, a cutter and a cutter support, the bridge comprising a pair of substantially parallel rods and the cutter support having means adapted to be snapper over said rods and make frictional engagement therewith to hold the cutter support at any desired position along the bridge.

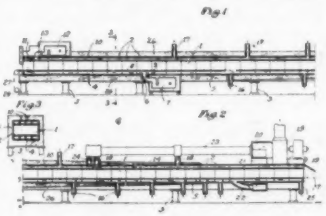


METHOD OF MOLDING GLASS AND APPARATUS THEREFOR. U. S. 1,589,654. June 22, 1926. Paul R. Murdock, Paden City, W. Va. Filed 4/28/25. A mold especially suitable for making glass letters, comprising a lower casing having a fluid (air) chamber, an upper casing having a fluid chamber, one of said casings being provided with cavities in its face, means for creating a difference in pressure in said chambers, and means for communicating the pressure difference to opposite sides of a sheet of glass arranged between said casings.

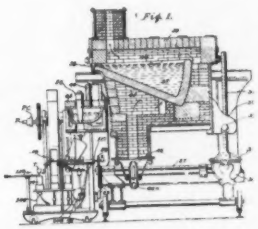


FEEDING MOLTEN GLASS. U. S. 1,589,304. June 15, 1926. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Empire Co. Filed 12/8/25. Objects of this invention are to provide means for influencing the shape of mold charges which are performed while being discharged in suspension from a supply of molten glass in a container, and to provide adjustments for glass shears, whereby the relative positions of the shear blades, and their vertical and lateral position in respect to the glass outlet, may be adjusted to suit changing requirements.

APPARATUS FOR ANNEALING GLASSWARE, U. S. 1,588,603. June 15, 1926. Virgil Mulholland. West Hartford, Conn., assignor to Hartford-Empire Co. Filed 8/27/25. A lehr for annealing glassware, comprising a tunnel, and means for causing a heating medium and a cooling medium to flow adjacent to different portions of a wall of said tunnel and in opposite directions with respect to each other to respectively heat and cool different zones in said tunnel.



GLASS-FEEDING APPARATUS. U. S. 1,588,393. June 8, 1926. Theodore C. Steimer, deceased, late of Pittsburgh, Pa., by Charles M. Steimer, executor, of Zanesville, Ohio, assignor, by mesne assignments, to Hartford-Empire Company. Filed 12/31/24. Mounted on a truck is a frame carrying a melting and delivering furnace which is pivoted and pours out the glass constantly at a fixed head. The glass flows in an unbroken stream into the interrupter chamber where, by means of a reciprocating interrupter, it is divided up into charges which drop through the funnel into a series of molds on a suitable pressing machine, where the charge of glass is automatically pressed and delivered. This patent covers the method of delivering glass from a source of supply through a spout, which comprises flowing a temperature modifying medium around and in contact with the walls of said spout, and then delivering such fluid into the spout interior above the glass line. Broader claims and claims on other features are reserved for the original application, or for other divisions thereof.



GLASS-WORKING MACHINERY. U. S. 1,591,175. July 6, 1926. Roy D. Mailey and Wilford J. Winninghoff, East Orange, N. J., assignors to Cooper Hewitt Electric Co. Filed 9/6/24. In the manufacture of a glass vessel comprising a main body and a smaller chamber connecting therewith, I find it expeditious to form these parts separately and then fuse them together to form a large chamber and the smaller chamber connecting therewith. An object of this invention to provide method and apparatus for working the two glass parts to fuse them together to form an article of the character described.

APPARATUS FOR DELIVERING VISCOUS GLASS. U. S. 1,593,290. July 20, 1926. Edwin P. Corbett, Columbus, O., assignor to Hartford-Empire Company. Filed 11/15/24. A spout for delivering viscous glass from a furnace comprising a body portion, with a delivery aperture therein, an outer lining for said body portion, and a layer of plastic material interposed between said outer lining and the furnace.

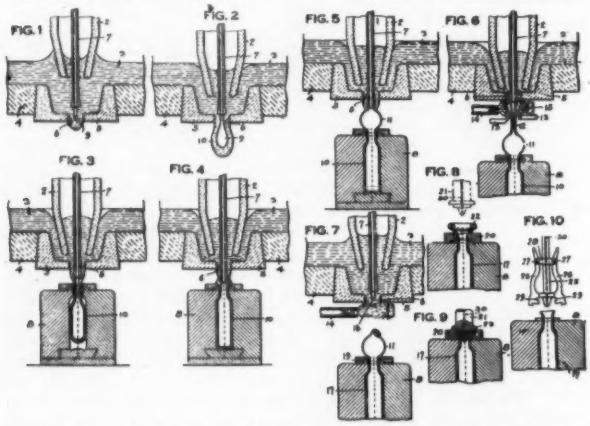
FURNACE FOR GLASS MANUFACTURE. U. S. 1,593,054. July 20, 1926. Pierre Arbeit, Paris, France, assignor to Manufactureurs des Glaces & Produits Chimiques de St. Gobain. Filed 11/19/24. In a continuously operating glass-making furnace, in combination independent melting and refining chambers arranged in separate blocks of masonry, means for separately heating the melting and refining chambers, passage means connecting the melting and refining chambers and electrical means for independently heating the passage means and controlling the flow of glass therethrough for the purpose described.

PROCESS OF INLAYING DESIGNS ON GLASS. U. S. 1,586,727. June 1, 1926. Sigmund Wurf, Boston, Mass., assignor of one-half to Crescenzo De Simone. Filed 6/14/24. The principal object of this invention is to provide a simple and efficient process for inlaying a predetermined design or emblem in mother of pearl, gold clippings, or other suitable material on glass for the ornamentation of trays and the like.

GLASS-CUTTING IMPLEMENT. U. S. 1,589,536. June 22, 1926. Munzio Luisi, Elmira, N. Y. Filed 1/6/25. The point or glass cutter may be readily removed for sharpening, replacement.

New Method of Bottle Blowing Eliminates Blanks

On an application filed July 8, 1921, a United States Patents No. 1,592,299 on a method and apparatus for making bottles and other articles, causing molten glass, while connected with the source of supply in a melting tank to descend through a shaping orifice to form a hollow parison, and then expanding the parison by air pressure in a blow mold while the glass



composing said parison is still connected to the source of molten glass supply, thus eliminating the forming of blanks previous to the blowing of the article in the mold as in the prevailing method, was allowed to George E. Howard, the inventor of the Howard Feeder, on July 13, 1926, and assigned to the Hartford-Empire Company, Hartford, Conn.

Figs. 1 to 7 are diagrammatic vertical sectional views showing the successive steps necessary to make a regular standard prescription bottle according to this invention, up to the point of finishing the neck; Figs. 8 and 9 are similar views showing one method of finishing the neck; Fig. 10 shows another method of neck finishing.

Incandescent lamp bulbs may be made in a similar manner.

Invisible Markings in Glass Made Visible at Will

Many persons who have observed the practice recently adopted by at least one manufacturer of lenses for eye glasses, of embodying in the glass a trade mark that normally is invisible but can be made temporarily visible at will by breathing upon it, have been much puzzled as to the method used to produce such a remarkable effect. The following abstracts from a United States patent (No. 1,592,429) issued on July 13, 1926, to Charles A. Krauss of Worcester, Mass., describe one invention to accomplish this object:

Manufacturers of optical lenses, mirrors, etc., have heretofore been unable to apply to the articles themselves any permanent trade mark free from optical damage to the article.

The inventor has discovered that it is feasible to qualify or alter the constitution of a glass, at and near its surface, over determined areas, which for marking purposes are delimited, in such manner as to produce marking which is normally invisible, instantly and easily developed into visibility, and which does not alter either the geometrical contour of the surface or the optical qualities of the glass as a whole.

Most glasses are built up from a mixture of acidic and basic oxides, those glasses which are in most general use comprise silica and metallic oxides such as sodium and calcium oxides. The more electropositive metals in these glasses are present in the form or association of salts; in the case of silicate glasses in the form of silicates. And, as with all true salts, the electropositive constituent, to some extent at least, is in the ionic condition; that is to say, the atom of the metallic element of the salt is present, carrying an electric charge. The condition of electrical unsatisfaction, due according to current theory to an unbalance between the orbital electrons of the atom and its positive nucleus, is manifested by a tendency of the ion, or electrically unsatisfied atom, to move in its environment; response to this tendency is regulated by the environing structure. In glasses, the ions of the more emphatically electropositive elements are not held in position rigidly, but are to a sensible degree free to move. Their freedom or rapidity of movement is, broadly speaking, proportionate to temperature. A glass in fluid or semi-fluid condition (practically so regarded) is a conductor of electric current; but even at temperatures where the glass is practically rigid the ions are movable and under suitable conditions will move, in the body of the glass.

The character of glass implied by its definition as a supercooled liquid accounts for this mobility of ions within it even at temperatures when, according to practical and mechanical standards, the glass is rigid or solid.

Thus, under the influence of a potential gradient, the electropositive ions in glass can be made to move; and furthermore, these ions likewise move under the influence of a concentration gradient; in other words, diffusion takes place. Interdiffusion, i. e., mutual or reciprocal diffusion, will manifest itself between the ions in a glass and ions in a salt in contact with the glass. Interdiffusion will take place even though both the glass and the salt in contact with it are mechanically rigid or solid. The above-noted characteristics of ions present in the structure of glass are utilized to carry out the process and form the product which are the subject matter of this invention.

Take for a specific example the ordinary soda-lime glasses, extensively employed in a miscellany of human uses; in such glasses the sodium ions are movable in the environing structure. If a salt, such as silver nitrate, is applied to a surface of a glass of this type although the deposit of such salt may be extremely thin as measured by ordinary standards, with respect and in relation to the movable ions such deposit is, in effect, a voluminous mass of silver nitrate in superficial contact with the mass of the glass. Under these conditions of contact interdiffusion takes place between the electropositive silver ions in the mass of silver nitrate and the electropositive sodium ions in the mass of the glass; the silver ions diffuse into the glass and the sodium ions diffuse out of the glass and into the silver nitrate. Thus, in the glass, which is the substance to be affected by the process, there is a replacement of sodium ions by silver ions in the region delimited by the distribution of the silver nitrate upon the glass surface. This replacement of sodium ions by silver ions does not alter the superficial contour of the glass, or affect its optical properties, the silica and other ingredients of the glass retaining their original position and arrangement, while the silver ions occupy positions formerly occupied by sodium ions.

It will now be apparent that the contour of the mass of silver nitrate deposited on the glass surface will presently be reproduced by an assemblage of silver ions which have diffused into the glass from a multitude of points distributed over the surface of contact between the silver nitrate and the glass; and that if the silver nitrate is deposited in the form of a mark or design, as for instance the trade mark of the maker of the glass, that mark or design is outlined in the glass by the assemblage of silver ions which have penetrated into its surface-portions.

If the replacement of sodium ions by silver ions is allowed to proceed only to a very slight degree, the pattern or mark outlined in silver ions in the glass will be wholly invisible, requiring other treatment to be rendered visible either temporarily or permanently. Therefore this local alteration of the constitution of the glass will not impair its utility for optical purposes; optical lenses, for instance, so marked are equally useful with and cannot be ordinarily distinguished from lenses not so marked.

But, since a thin film, of delimited area and intended shape or design, of the surface-portion of the glass has been altered by the substitution of silver ions for sodium ions, it is possible to make this altered film visible: To render it temporarily visible, which will be all that is required for the detection of a trade mark, all that is necessary is to condense the vapor of a suitable liquid upon the surface of the glass. When a liquid comes in contact with a solid surface, there is a definite interaction between the liquid and the solid surface, dependent on the nature of both. When a vapor is condensed on a solid surface, minute drops are formed, and the number, size, and density of distribution of these drops depends on the nature of the liquid and that of the solid. The surface of a soda-glass which has been locally altered as by the exchange of silver ions for sodium ions exhibits a differential in effect upon condensed moisture, so that if a glass so marked is breathed upon, under temperature conditions which produce condensation, the water condensed on the silver-marked portion of the surface differs in the arrangement of the drops from the water condensed on the unaltered surrounding or adjoining surface to such a degree that the mark is distinctly contrasted with the adjacent glass surface, and can readily be seen so long as the moisture remains condensed.

Annual Meeting of Flint and Lime Glass Manufacturers

Interesting Address of the Retiring President

This year's annual convention of the American Association of Flint and Lime Glass Manufacturers was held as usual in Ocean Hall, Hotel Marlborough-Blenheim, Atlantic City, on July 19. The meeting opened with an address by the president, W. A. B. Dalzell, which is given in full below.

Several committee reports including that of the treasurer and one from the traffic committee were submitted.

A committee of three, including C. B. Roe of the Fostoria Glass Company, E. A. Gillinder of Gillinder & Sons, Inc., and F. J. Murray of the United States Glass Company, was appointed by President Dalzell to select officers for the coming year. The newly elected officers were C. M. Rodefer of the Rodefer Glass Company, president; and W. T. Gillinder of Gillinder Bros., Inc., second vice-president, while Nicholas Kopp of the Kopp Glass Company, first vice-president; E. P. Ebberts of the Phoenix Glass Company, treasurer, and John Kunzler, secretary, were re-elected.

An impromptu address was made by the new president, C. M. Rodefer, who, while he said he appreciated the unexpected honor, expressed great reluctance to accepting the office, but this was not agreed to by those present who waved aside his objections. Mr. Rodefer, during his talk, mentioned that the subject of package charges was an important matter for attention and was still in a very unsatisfactory condition inasmuch as some manufacturers had entirely discontinued the charges or had made reductions, while others included the charges in the price of the article. He stated that he believed that the rulings of the association should be strictly adhered to. A motion was then passed affirming the present package price.

A suggestion was made by E. A. Gillinder that a committee be appointed to get the lighting glass manufacturers together and make an effort to have the package charges billed as a separate item on all illuminating glassware invoiced in the manner practiced by tableware manufacturers. Mr. Gillinder was authorized to act as chairman and appoint his associates.

A resolution expressing regret over the death of James D. Wilson, treasurer of the National Association of Manufacturers of Pressed and Blown Glassware, was passed.

Word was received from Marshall W. Gleason of Gleason-Tiebout Glass Company, for many years president of the association, that owing to illness in his family he regretted being unable to again attend the annual meeting but that he wished the Association continued success.

Mr. Dalzell's Address

This nation has passed safely through 150 years of progress. Our association has passed safely through more than fifty years of this remarkable period. We can say with great satisfaction that our industry has developed in keeping with other industries and has steadily advanced in the right direction.

The rapid invention of automatic machinery for gathering, pressing, blowing and conveying glass, combined with the development of the continuous tank, has made it possible for our members to produce glassware in quantities and at costs never dreamed of twenty years ago. We also make, today, in large volumes, by hand pressing and blowing, some of the finest glassware to be found in the world's markets. This is the result of our wider knowledge of the use of glass chemicals and the attainment of higher standards in designing, and greater genius in mold making.

Fifty years ago, when all glass was melted in pots, the glass usually ranged in color from red to green in every pot. The top glass had a red tinge, the center was fairly good, and the bottom had a green tinge. By using purer raw materials and better chemicals for neutralizing the effects of impurities, we now make uniform glass in pots from the top to bottom. Years ago we also used heavily figured molds to cover the defects of the glass, and I remember one of the first popular pressed patterns had small birds in profusion. It went nicely with the seedy glass, so that we supplied not only the birds but the bird seed without extra charge. While tank glass years ago was expected to vary widely in color, today tank glass approaches closely the uniformity in color of pot glass, and the trade appears more critical of the color and quality of the fruit jar than of the finest pieces of imported ware. I see some imported glass which reminds me of the glass we used to make in this country after the first melt was worked out each week. Such glass will not be accepted from American manufacturers today, while the imported seedy glass still seems to be purchased with all its defects.

The revival of interest in colored glassware has stimulated production in tableware factories so that continuous operations have generally prevailed for the past two or three years. Competition from foreign countries is rapidly increasing, however, in hand-made blown glassware and is interfering seriously with the continuous operation of these factories. The importation of blown glassware, cut or decorated, in March of this year, was valued at $225,000, while in March of last year importations of this ware totaled only $137,000, according to the United States Government statistics. The increase in this month was 63%. The increase for the preceding nine months was of similar proportions. These figures are based on foreign valuation, as the duty is paid on that basis. The American valuation would be at least four times this total. The amount of blown glassware imported each month equals the yearly production of the average blown tableware factory, and the yearly volume of imported blown ware would require the total production of ten of our largest factories. The low scale of wages paid to foreign glass workers is the greatest handicap in meeting this competition. For the equivalent of every American dollar that a foreign manufacturer spends for labor, we pay out four dollars for similar labor. In order to offset this low cost of foreign production we have only 55% ad valorem duty on blown glassware, which is also based on foreign valuation. Thus the future for hand-blown glassware in America looks critical.

The imported glassware is not retailed cheaper than comparable American glassware, and since large profits are thereby made on it, sales are being pushed.

We cannot complain of the rate of wages paid in the glass industries of America, for they are not unreasonable, but compare favorably with the wages that are paid to other skilled labor in America.

We do not want to see the American standard of wages or standard of living reduced to that of our foreign competitors, although many say our tariff is too high and should be lowered. Those who claim this are asking for a repetition of the year 1893. Complete idleness in all manufacturing can bring down the standard of wages and living, but we predict that complete idleness for a period will not bring wages down. It will only result in a year or two of stagnation in business, which means "soup-kitchens." Idleness is something we all should use our energy to avoid.

During the World War and for some time afterwards we enjoyed a large export business in various lines of glassware. Today the only glassware exported in quantities is the automatic machine-made glassware, confined largely to staple articles on which the labor item is not a large factor. While hand-made blown glassware is in great demand because it is artistic and very attractive, the labor costs, required mainly for skilled workmen, are 70% of the total cost. Thus exportation is practically prohibited by the high wage scale paid in this country. The automatic machine-made glassware, however, is encountering a handicap in the export business by the policy being adopted in many foreign countries, viz.: prohibiting any article to be imported into their country that they can manufacture themselves, regardless of the price. How different this policy is to ours at home, where it seems that a large number want to buy in the cheapest markets of the world and pay only a small duty to make it worth while to keep the statistics, even if our manufacturers are idle. They don't seem to understand that we manufacturers of glassware are better than gold mines to our country-at-large, for we take the natural elements, such as sand, soda ash (made principally from salt), lime, lead, and coal, and convert these into money. This nation is so wealthy because our manufacturers are doing this, yet it seems that it is not realized very generally or our appeal for protection would be given more attention. When our last tariff was enacted, we asked for a tariff based on American valuation, or 90% based on foreign valuation, but was only granted 55%.

Our association should make an earnest effort to gather more statistics from our members than we have in recent years. If our actuary was posted and could give your tariff committee the

amount of business transacted by our members and the amount of wages paid, it would add much weight to our arguments before the congressional committees. They should know the amount of business of all our members each year in the classes in which we are interested, and what proportion the labor costs are to the total cost of each kind of ware. Many other statistics collected from uniform cost systems would be valuable.

Recently it came to me that there is a vast difference in the workmen's compensation rates in the different states. This is wrong and it is a situation that we should take steps to remedy.

We have many problems that can be handled successfully only by the co-operation and loyal support of all our members. Each year some of the old guard drop from our ranks, but the high motives and sound principles on which this association was founded fifty years ago still guide our actions today.

Among those present, besides some who attended but who did not register, were the following:

R. C. Faris, Belmont Tumbler Company, Bellaire, O.
George Dougherty, Economy Glass Company, Morgantown, W. Va.
W. A. B. Dalzell, Fostoria Glass Company, Moundsville, W. Va.
C. B. Roe, Fostoria Glass Company, Moundsville, W. Va.
E. A. Gillinder, Gillinder & Sons, Inc., Philadelphia, Pa.
James Gillinder, Gillinder Bros. Inc., Port Jervis, N. Y.
Charles Gleason, Gleason-Tiebout Glass Company, Brooklyn, N. Y.
Victor G. Wicke, Imperial Glass Company, Bellaire, O.
C. J. Nolan, Inland Glass Company, Chicago, Ill.
M. A. Smith, McKee Glass Company, Jeannette, Pa.
Ira M. Clarke, New Martinsville Glass Mfg. Co., New Martinsville, W. Va.
E. P. Ebberts, Phoenix Glass Company, Monaca, Pa.
James W. McCreary, Phoenix Glass Company, Monaca, Pa.
C. M. Rodefer, Rodefer Glass Company, Bellaire, O.
David Yost, United States Glass Company, Pittsburgh, Pa.
F. J. Murray, United States Glass Company, Pittsburgh, Pa.

In addition to the glass manufacturers present at the meeting the following represented the press: T. A. Kimes, *National Glass Budget;* J. G. Kaufmann, *American Glass Review;* F. Calvin Demarest, *Crockery and Glass Journal;* Howard R. Handy, *Pottery, Glass and Brass Salesman,* and R. D. Proctor, GLASS INDUSTRY.

Glass Factory Equipment and Supplies

Most of the information printed in this department comes direct from the manufacturers of the products described.

Large Gas Engine Installations

Few people in the glass field, aside from those directly interested in production activities, have an adequate conception of the quantity of electric power required for various purposes throughout a modern glass plant. Coal and gas are the principal fuels used for developing the power. Examples of two very large generator installations in different plants are shown in the accompanying cuts. Fig. 1 shows the Libbey-Owens Sheet Glass Company's power plant at their Charleston, W. Va., factory. It consists of five 25 x 36 C. & G.. Cooper single-tandem engines, driving 550 K. V. A., 480-volt, 60-cycle alternator. This, it is said, is the largest generator installation ever constructed by the C. & G. Cooper Company.

Fig. 2 shows power equipment in operation at the Charles Boldt plant at Huntington, W. Va., which recently became the property of the Owens Bottle Company, Toledo, O. This installation,

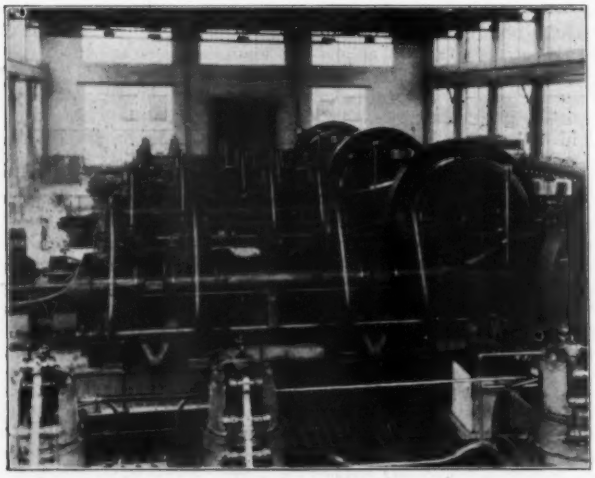


FIG. 1

which, as shown in the photograph, is set between two rows of lehrs, consists of an engine of 570 B. H. P., also built by the C. & G. Cooper Company, Mt. Vernon, O., which drives a 350 K. W. 250 volt generator.

The C. & G. Cooper Company controls the Chapman Engineering Company and the Chapman-Stein Furnace Company.

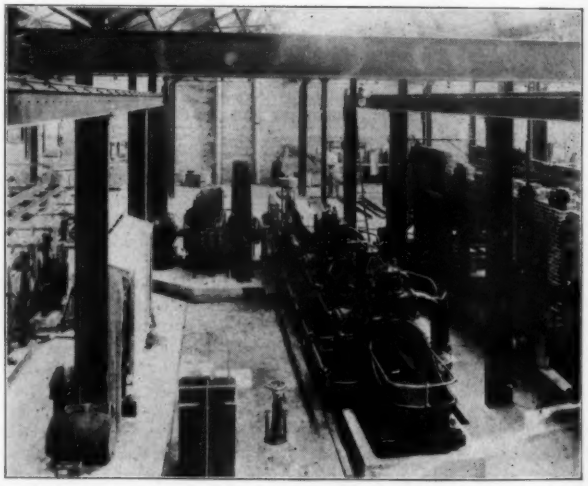


FIG. 2

The Austin Company Large Buyers of Glass

Those of our readers who plan to visit the Sesqui-Centennial Exposition of Philadelphia this summer will be interested to know that one of the principal buildings there, an enormous structure, the Palace of Agriculture, was erected by a concern well known to many glass men, The Austin Company, engineers and builders, of Cleveland, O., to whose credit there are numerous modern glass plants standing as substantial evidence of the efficiency of their methods. Their building operations in this industry have extended even to foreign countries and their activities include not only the designing and construction of industrial plants but also the financing of such projects.

The Palace of Agriculture is 460 feet wide by 980 feet long, the side walls are 37 feet in height and the building steps up to a height of 60 feet in the center aisle. It is of steel frame construction, with monitors in the roof to admit floods of daylight and an abundance of ventilation. The exterior wall treatment of the building is stucco of a light tint.

This building was started September 17, 1925, and substantially completed on March 1st. The interior floor space was turned

over to the Exposition Board on this date; a small amount of exterior trim on the towers being the only work undone.

Coupled with the Philadelphia job, a recent achievement of the California branch of The Austin Company demonstrates the breadth of their operations in this country and that their facilities and resources are quite sufficient to cover the territory from the Atlantic to the Pacific. This achievement is a motion picture plant which has been designed and erected at Burbank, Cal., for the First National Studios. In this work over 50,000 square feet of glass were used, all of which was furnished by the Dixon Glass Company, of Los Angeles. The ribbed glass was made by the Columbia Glass Company at Huntington Park, Cal., and the clear glass came from the plant of the Standard American Window Glass Co., at Santa Ana. All clear glass is machine with latest type machines. Although about three days normal output of the factories were required for this job there was no delay in the delivery. The huge stages, 250 x 135 feet, were entirely without windows or skylights but close to a thousand boxes were required in the administration buildings, dressing rooms, and mill buildings. Florentine glass was used in all the 250-odd dressing rooms while ribbed glass was used in all the industrial buildings. The carpenter shop and machine shop which are of Austin daylight design required 13,000 lights of glass for the steel sash.

The Glass World and What It Is Doing

News of the Industry

Glass Container Association Meeting

As we go to press the members of the Glass Container Association are meeting at the Marlborough-Blenheim Hotel, Atlantic City. The meeting opened Thursday, July 29th, and was continued over to Friday, the 30th. The meeting on Thursday afternoon was addressed by Dr. Aubrey L. Faubel, secretary of the American Protective Tariff League and Professor of Economics in New York University. At the Friday morning meeting, Warren Bishop, managing editor of *Nation's Business*, addressed the members on "The Trade Association and the New Competition" and on Friday evening an informal dinner was held at the Hotel Traymore. On Saturday a number of the members had a good time playing golf, arrangements for which were in charge of Parker Levis of the Illinois Glass Company, Bridgeton, N. J.

Investigation of Foreign Plate Glass Goes On

Early last month an appeal for a higher tariff against foreign-made plate glass was presented to the Tariff Commission on behalf of the automobile interests of the country. The General Motors Company was represented by Royal T. McKenna and he and Representative John Sosnowski of Detroit, put the matter before Chairman Thomas O. Marvin, who informed them that the Commission has agents at present in Belgium and Great Britain investigating new methods of manufacture and obtaining information regarding costs. After the investigation is completed, probably in December, it is possible that an emergency tariff bill based on the information obtained for the Commission will be prepared.

A Million Dollars to Develop Plate Glass Process

According to a statement made by C. W. Brown, president of the Pittsburgh Plate Glass Company, and as mentioned in the July issue of the GLASS INDUSTRY, the original experimental continuous process tank at the Ford City, Pa., plant of the company is to be rebuilt and other extensive changes and improvements made, for the purpose of continuing experiments with what is believed to be a still better process than that now in use at Creighton for making plate glass. Captain Brown said that the present continuous method in many ways is satisfactory, yet the company has not fully realized their expectations and believe they have discovered a still better method. The directors have authorized an initial expenditure of $1,000,000 for making the changes mentioned above and continuing the experiments. No outside financing will be done.

New Ceramic Course Opens Next Fall

A new course in ceramic engineering has been established by the School of Mines and Metallurgy, University of Missouri, Rolla, Mo., at the request of the clay industries of Missouri. As a means of interesting students in the new course the Clay Industries Association has voted three scholarships of $100 each to be awarded to students enrolling in the ceramic course next fall. Dr. M. E. Holmes, who was for some time chemical director of the National Lime Association and for the past three years connected with the Ceramic Experiment Station of the United States Bureau of Mines at Columbus, O., doing research work, has been appointed head of the new department.

Biggest Month's Production of Plate Glass in June

Production of polished plate glass in the United States in June was 12,525,221 square feet, a new high record, making the total for the second quarter of 1926, 34,279,612 square feet, as compared with 29,546,079 square feet for the corresponding period in 1925. The total production for the half year ending June 30, 1926 amounted to 67,168,979 square feet as compared with 56,561,960 square feet for the first half of 1925, an increase of approximately 19 per cent. The first six months' production of 1926 equalled 57 per cent of the total production for the whole year 1925, which amounted to 117,224,298 square feet.

Eastern Distributors' Fall Meeting

The fall meeting of the Eastern Division of the National Glass Distributors' Association will be held at the Hotel Traymore, Atlantic City, on September 28, 29 and 30. The meeting will begin with a dinner for members of the eastern executive committee only, at 6:30 P. M. On Wednesday a general meeting of the Eastern Division will be held at 10:30 A. M. and a luncheon at 1:00 P. M. at which all members and manufacturers will be welcome. In the evening a dinner and dance will be held. All of these functions take place at the Traymore. On Thursday there will be a golf tournament at the Northfield Country Club to which all members and guests are invited.

September Meeting of Mirror Manufacturers

Harry C. Sorden, secretary of the Mirror Manufacturers' Association, announces that the date for the next meeting has been changed to September 28, because of a change in the date of the meeting of the Eastern Division of the National Glass Distributors' Association, hotel accommodations not being available during the previous week which had originally been selected. The Mirror Manufacturers' date was changed in order to have the advantage of meeting at the same time as the distributors.

Volume of Construction Contracts Well Maintained

Building and engineering construction contracts declined in volume very slightly in June, according to the F. W. Dodge Corporation building report. The decrease was less than 1 per cent from the month of May and 2 per cent from the total volume of June, 1925. Contemplated building and engineering work for the 37 states east of the Rocky Mountains was reported in June to the amount of $807,281,800, which is an increase of 2 per cent over that of May of this year and 16 per cent above the amount reported in June, 1925.

Safety Glass in Motor Cars

The use of safety glass in all the windows of the new "Safety Stutz" automobile is being announced in full page newspaper advertisements. These models, including the seven passenger car, will have every window and windshield of special safety glass. It is stated that these models are the first cars regularly equipped with safety glass all around.

Irish Free State Glass Trade

The Ministry of Industry and Commerce of the Irish Free State has lately issued a return showing the imports into the country during last year as compared with 1924, from which we have compiled the following table showing the imports of glass into the Free State. It will be seen that there was a marked decline in the imports last year:

	1925		1924	
	Quantity	Value	Quantity	Value
Domestic and Fancy Glassware, cwt.	15,301	$239,055	22,273	$342,835
Illuminating Glassware	....	102,420	....	111,740
Plate Glass, sq. ft.	208,201	117,320	282,088	233,335
Other sheet glass, sq. ft. 2,720,863		243,650	2,491,520	285,390
Bottles (dutiable) gross.....	56,132	231,250	8,113	31,705
Bottles & jars non-dutiable) gross.	33,599	148,620	98,346	482,240
Glass & glassware n.e.s., cwt.....	3,567	107,475	4,796	123,745
		$1,189,790		$1,610,990

Although of the imports $962,690 or about 80% are credited to the United Kingdom, it does not follow that the goods are all of British manufacture, the official returns only taking cognizance of the ports of shipment; of the balance, $128,745 are credited to Belgium, $75,575 to Germany, and $21,840 to Czechoslovakia.

Close Call for a Glass Man

A close escape from death in a pit of molten glass by James (Jimmie) Livers, foreman at the Graham Glass Company's plant in Evansville, Ind., was reported by the Loogootee, Ind, *Tribune*. After the bursting of a large tank had allowed about 100 tons of molten glass to pour into the basement pit a wooden plank was placed from the outside edge of the pit to the furnace. Not knowing that the terrific heat from the glass had charred the under side of the board, Mr. Livers had started to cross it to shut off a valve. The board began to give way and Mr. Livers clutched an iron furnace rod above his head. To have let go would have meant instant death. He was rescued by a workman who managed to get him down from the iron rod. His hands were badly burned.

Lippincott Glass Company Again in Receiver's Hands

On July 21, the Superior Court appointed S. G. Phillips and H. M. Adams receivers for the Lippincott Glass Company, Alexandria, Ind. The receivers issued a statement on July 23 stating that they were not then fully advised as to the assets and liabilities of the company but expected to have a complete inventory within ten or fifteen days.

Trade Activities

The Demuth Glass Manufacturing Company has moved its New York office, formerly at 32 West Broadway, to its factory at Newtown Creek, at foot of Lombardi street, Brooklyn, N. Y.

The Reliance Glass Company's building at Dubois, Pa., which has been in disuse for several years, was destroyed by fire on the night of July 4. Supposedly the fire was of incendiary origin.

The Pittsburgh Plate Glass Company and the **McMurtry Manufacturing Company** of Denver, Colo., are reported to have purchased the business, stock and factory of the McPhee & McGinty Lumber Company, of Denver

The Harding Glass Company Plant No. 2, Fort Smith, Ark., is reported to have begun operations on July 14 with an initial staff of 150 glass workers. The plant will produce machine made window glass.

The quarterly statement of the **Hazel-Atlas Glass Company** issued July 20 shows income for the period ending June 30, after reductions for operating expenses totaled $1,240,895, a net gain of $666,962 for the quarter.

Reports from Quebec state that the **Canadian Glass Products, Ltd.**, a recently organized concern, has purchased a building at Wrightville, Hull, Quebec, and will establish a sand pulverizing plant at a cost of approximately $100,000.

The H. Northwood Glass Company's plant, equipment and materials, at Wheeling, W. Va., were sold at public auction on July 14 to Robert Hazlett, president of the Dollar Savings and Trust Company, the largest creditors. Efforts are being made, it is said to organize a new company to reopen and operate the plant.

The American Flint Glass Workers' Union at their annual convention at Philadelphia on July 15, re-elected William P. Clarke as president for the coming year, as well as all the other officers. The committee adopted resolutions favoring a higher tariff on glassware manufactured in Europe that comes into competition with American-made ware.

The Union Glass Company, Somerville, Mass., of which Charles H. Glazier is treasurer and general manager, announce that they are making the largest line in the world of high grade hand made lead and potash glass blanks for cutting and engraving. Colored tableware is also produced. This is one of the oldest glasshouses in the United States that has been continuously operated.

The B & B Glass Company, 988 Bergenline avenue, Jersey City, N. J., was recently incorporated to manufacture glass and is authorized to issue stock to the amount of $125,000. It starts in with $1,000 paid in by William and Margaret Bower, 933 Ann street, North Bergen, and John R. Ricktenwald, 69 Palisade avenue, Jersey City.

The Owens Bottle Company, Toledo, O., recently awarded to the Rust Engineering Company, of Pittsburgh, a contract for a $250,000 warehouse at their Charles Boldt plant at Huntington, W. Va. The construction of the $500,000 warehouse for the Owens concern at its Kanawha City, W. Va., plant, which is also being done by the Rust Engineering Company, is well under way and completion of the building is expected by September first.

The plant of the **United States Window Glass Company**, Morgantown, W. Va., closed since May 7, 1925, will be auctioned August 5, according to Attorney Frank P. Corbin, special master, appointed by Federal Judge W. E. Baker. It is expected that the bondholders for whom the Guarantee Trust Company of Cleveland is trustee, will make a bid on the property with the object, if the plant comes into their possession, of resuming operations as early as possible.

The plant of the **Pittsburgh Sheet Glass Company** at Washington, Pa., was sold at a receiver's sale on July 12 to F. Guy Ash of Morgantown, W. Va., for $249,699. Only $4,950 was paid in cash, the purchaser assuming a mortgage for the balance, which equals the mortgage and taxes that are a lien on the property. Mr. Ash, who was one of two bidders at the sale authorized by the United States District Court in an action brought by Walter A. Jones stated that he had made the purchase for a glass manufacturing company but declined to reveal its identity. The second bidder was Edgar B. Stewart of Pittsburgh.

The Cooper-Hewitt Electric Company, 9 River street, Hoboken, N. J., has had plans prepared for a six-story, 100 x 430 ft. building. The new building will be located opposite the present works and, according to George R. Brewster, assistant sales manager, is the first of a series of additional units to meet the demand of the company's increasing production. This unit will house the general offices, sales offices and laboratories and the factory portion of the building will contain the glass working departments for making glass tubes for mercury vapor arc lamps for industrial illumination known as the Cooper-Hewitt Work-Light, also glass mercury Konnec-tors or switches for electrical purposes and Uviarc quartz burners now very widely used as a source of ultra-violet light.

The General Flat Glass Company of Mannington, W. Va., has been organized under the West Virginia laws to manufacture sheet glass, with an authorized capital of $300,000 preferred stock, 3,000 shares of $100 par value, and 15,000 shares common stock, no par value. Five thousand shares of common stock, it is reported, were allotted to H. E. DeVaughn and J. L. Keener for the right to use a certain type of drawing chamber. The company has acquired a plan at Mannington. H. D. Atha of Mannington is president of the new company; J. L. Keener, vice-president and H. E. DeVaughn, second vice-president, both of Morgantown; Charles W. Prichard, secretary; Chester L. Prichard, treasurer; R. F. Alder, manager, all of Mannington. The above individuals with S. E. Phillips, constitute the board of directors.

The factory will be in charge of R. F. Alder, formerly with the Mountain State Window Glass Company. H. E. DeVaughn will act as chief engineer and J. L. Keener as sales manager. The two last mentioned men have had long experience in window glass manufacture.

The Weston Glass Company, Inc., Weston, W. Va., has increased its capital stock from $100,000 to $250,000.

Harry E. Collin, an industrial banker, prominent in the middle west, has been elected a director of the Owens Bottle Company, Toledo, O., to fill the vacancy caused by the death of F. P. Kennison.

Discussing the recent sale of the **H. Northwood** plant, originally the Hobbs-Brockunier plant, the *Wheeling Intelligencer* said: It has had a most useful and honorable career in the industrial life of Wheeling. The leading glass makers of this valley had their training in the Hobbs-Brockunier factory; and for many years, it was conducted as a highly profitable institution.

About 1904, the plant was taken over by the H. Northwood Co., being conducted very successfully under the management of the late Mr. Harry Northwood. It continued a prosperous career until about 1920 when industrial conditions changed, and the plant had two or three years of heavy losses.

What Our Advertisers Are Doing

The Chapman Engineering Company, Mt. Vernon, O., announce that the Graham Glass Company, Evansville, Ind., recently contracted for two 10 ft. automatic feed floating agitators. These agitators will modernize two more of the company's old style hand feed producers. The Owens Bottle Company, Huntington, W. Va., has also placed a contract with the Chapman Company for three revolving pot recuperators. This is the third unit of this kind installed. The present contract covers laying of foundation and installation of recuperators complete. These will replace regenerative pots of an older type.

The Akro Agate Company, Clarksburg, W. Va., recently contracted for a 60 in. x 100 in. day tank complete with stack type recuperator, and the Macbeth-Evans Glass Company is adding a Chapman-Stein recuperator to its 12-ton continuous tank at Charleroi, Pa.

Personals

Stuart M. Phelps, who has been employed on the Refractories Fellowship since 1918, has been appointed director of research of the American Refractories Institute, effective July 1, 1926. Mr. Phelps will have charge of the investigational and testing activities of the Fellowship.

G. G. Hanson, 2642 North Mozart street, Chicago, Ill., has been appointed western representative of the Golding Sons' Company and the Erwin Feldspar Company, Inc., both of Trenton, N. J., and will represent them for the sale of feldspar, kaolin, ball clays, sagger clays and Cornwall stone in the states of Missouri, Kentucky, Illinois, Michigan and Wisconsin.

MacDonald C. Booze, Senior Fellow of the Multiple Industrial Fellowship which is sustained by the American Refractories Institute at Mellon Institute of Industrial Research, University of Pittsburgh, has resigned to accept a position with the Charles Taylor Sons Company, Cincinnati, O., as vice-president in charge of research and development. Mr. Booze, who has been very active in the refractories industry since 1923, when he became a member of Mellon Institute, has contributed valuably to the knowledge of refractories and their uses.

Recent Deaths

Charles Wandless, president of the Columbus Plate & Window Glass Company, Columbus, O., died at his home in that city on July 8, from sleeping sickness, following an attack of influenza from which he never fully recovered. Mr. Wandless was born in Pittsburgh sixty years ago. About 1894 he organized the Columbus Plate & Window Glass Company at Columbus, taking over the window glass factory at Lancaster, O., which was later absorbed by the Interstate Window Glass Company. Mr. Wandless continued his jobbing business in Columbus.

He is survived by his widow, a son, a daughter and brother.

Coming Meetings

AMERICAN CERAMIC SOCIETY summer meeting will be held August 30 to September 2 at Bellevue-Stratford Hotel, Philadelphia, Pa., during Ceramic Week of the Sesqui-Centennial Exposition.

THE EASTERN DIVISION OF THE NATIONAL GLASS DISTRIBUTORS' ASSOCIATION will hold its fall meeting at the Hotel Traymore, Atlantic City, N. J., September 28, 29 and 30.

THE AMERICAN BOTTLERS OF CARBONATED BEVERAGES will hold its eighth annual convention and exposition at Buffalo, N. Y., November 8 to 12, 1926.

THE AMERICAN CHEMICAL SOCIETY. Fiftieth anniversary, Golden Jubilee, Philadelphia, September 6 to 11. Three thousand chemists from all parts of the world are expected. Gas and fuel chemistry and industrial and engineering chemistry are among the subjects that will be discussed.

THE SIXTH CONGRESS OF INDUSTRIAL CHEMISTRY will be held in Brussels, Belgium, from September 26 to October 3, 1926.

MIRRORS MANUFACTURERS' ASSOCIATION will hold their next meeting at Atlantic City, September 28.

Inquiries Received

For Further Information Address GLASS INDUSTRY.

338. We desire to procure 300 each of blue and yellow signal lenses, 3 inches in diameter to be used in the new Hudson River vehicular tunnel. (July 16)

339. Do you know the address of a company manufacturing a glass substitute that is known as "rolled glass" which is used for windows in poultry houses, cellars, garages, etc., and which is comprised of wire mesh embedded in a sheet of transparent material. (July 14).

340. We would like to have a source of supply of equipment for resilvering mirrors. We have no equipment at present. (July 21)

341. (From England) We would like the names of manufacturers of glass humidors with lid as containers for cigars, approximate dimensions 6½ inches deep by 6¼ inches diameter (internal measurements for a circular container). The quantity required would be approximately 2,000 and 5,000 lots. July 27.

What the World Wants

Specific Inquiries for American Goods Received in the Department of Commerce

Australia: 21331, sheet glass, and rolled white and tinted decorative glass.
India: 21333, glassware.
New Zealand: 21334, glassware.

Glass Stock Quotations

PITTSBURGH STOCK EXCHANGE, JULY 23, 1926.

Reported by Moore, Leonard & Lynch, Union Trust Building, Pittsburgh, Pa.

	Bid	Ask	Last
American Window Glass Machine, com..	62¼	..	63
American Window Glass Machine, pfd....	..	..	86
American Window Glass, pfd.....	..	..	108½
United States Glass.....	15⅝	..	15⅝
Pittsburgh Plate Glass, com.....	280	..	280
Standard Plate Glass, com.....	6⅜	..	6½
Standard Plate Glass:			
Preferred cumulative	31	47	32½
Prior preferred	77	..	78

WHEELING STOCK EXCHANGE, JULY 23, 1926.

	Bid	Ask	Last
Hazel-Atlas	..	..	48
Imperial	..	..	72
Fostoria	..	..	150
Central	..	..	75

TOLEDO STOCK EXCHANGE, JULY 23, 1926.

	Bid	Ask	Last
Owens Bottle Machine, com.	..	..	..
Libbey-Owens Sheet Glass, com.	..	..	142
Libbey-Owens Sheet Glass, pfd.	..	..	..

Current Prices of Glass-Making Materials

July 23, 1926

Quotations furnished by various producers, manufacturers and dealers

		Carlots	Less Carlots
Acid:			
Citric	lb.	.44½	.44½
Hydrochloric (HCl) 20° tanks, per 100 lb.	lb.	.95-1.05	..
Hydrofluoric (HF) 60% (lead carboy)	lb.	..	.13½
52% and 48%	lb.	..	.11-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.	lb.	5.50	5.75
Sulphuric (H_2SO_4) 66° tank cars	ton	15.00-16.00	..
Tartaric	lb.	.29	.29½
Alcohol, denatured	gal.	..	.37½
Aluminum hydrate (Al $(OH)_3$)	lb.	.05	.05½
Aluminum oxide (Al_2O_3)	lb.	..	.05
Ammonium bifluoride (NH_4) FHF	lb.	..	.23-.23¼
Ammonia water (NH_4OH) 26° drums	lb.	..	.03½
Antimony, metallic (Sb)	lb.	..	.15½
Antimony oxide (Sb_2O_3)	lb.	..	.14-.16
Antimony sulphide (Sb_2S_3)	lb.		
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.03½	.04
Barium carbonate ($BaCO_3$)			
Precipitated	ton	51.00-55.00	51.00-58.00
Natural, powdered, imported	ton	42.00-44.00	45.00-46.00
Barium hydrate ($Ba(OH)_2$)	lb.	..	.43-44
Barium nitrate ($Ba(NO_3)_2$)	lb.	.07¾	.08
Barium selenite ($BaSeO_3$)	lb.	..	..
Bone ash	lb.	.05½	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	.04¾	.05-.05½
Boric acid (H_3BO_3)	lb.	.09	.09¾
Refined	lb.	.08½-.09	.09-.09½
Cadmium sulphide (CdS)—			
Red	lb.	..	1.20
Orange	lb.	..	1.05-1.25
Yellow	lb.	..	1.20-1.40
Chromium oxide (Cr_2O_3)	lb.	.29	.30-.32
Cobalt oxide (Co_3O_4)			
In bbls.	lb.	..	2.20
In 10 lb. tins	lb.	..	2.10
Copper oxide			
Red (Cu_2O)	lb.	.	.30
Black (CuO)	lb.	..	.25
Black prepared	lb.		.30
Cryolite ($Na_3Al F_6$) Natural Greenland			
Kryolith)	lb.	..	.09½-.09½
Artificial	lb.	..	.09
Epsom salts ($MgSO_4$) (imported) Per 100 lb.		1.25	1.35
Feldspar—			
100 mesh	ton	11.00-20.00	16.00-22.00
80 mesh	ton	..	..
40 mesh	ton	..	..
Fluorspar (CaF_2)—			
Powdered white, 95%	ton	40.00	..
" " 90%	ton	38.00	..
Formaldehyde	lb.	.09	.09½
Graphite (C)	lb.	..	.04-.07
Iron oxide—			
Red (Fe_2O_3)	lb.	..	.02-.03
Black (FeO)	lb.	..	..
Kaolin (f.o.b. mine)	ton	10.00	..
English, lump, f.o.b. New York	ton	13.00-23.00	..
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb.	..	..
Lead oxide (Pb_3O_4) (red lead)	lb.	11½-.11¾	.11½-.11¾
Litharge (PbO)	lb.	.11	.11-.11¼
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	12.50	..
Burnt (CaO) ground, in bulk	ton	9.00	..
Burnt, ground, in paper sacks	ton	11.00	..
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.15	2.30
Limestone ($CaCO_3$)	lb.	..	..
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb.	.04	.04½
light (in bbls.)	lb.	.22	.24
extra light (in bbls.)	lb.	..	.32-.37
Magnesium carbonate ($MgCO_3$)	lb.	.06¼	.06¾
Manganese 85% (MnO_2)	lb.	.05	.06
Nickel oxide (Ni_2O_3), black—			
for nickel content	lb.	..	.35
Nickel monoxide (NiO), green—			
for nickel content	lb.	..	.35
Plaster of Paris, bags	ton	..	19.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.08¼	.08½
Ground	lb.	.11	.12
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.06½	.06¾
Hydrated 80-85%	lb.	.05¾	.06
Potassium chromate (K_2CrO_4)	lb.	..	.27
Potassium hydrate (KOH) (caustic potash)	lb.	.07⅛	.07⅝
Potassium nitrate (KNO_3) (gran.)	lb.	.05⅞-.06⅛	.06¼-.06⅜
Potassium permanganate ($KMnO_4$)	lb.	.14½	.15
Powdered blue	lb.	..	.24-.26
Rochelle salts, bbls.	lb.	..	.20
Rouge	lb.	..	..
Rutile (TiO_2) powdered, 95%	lb.	.20	.25
Salt cake, glassmakers (Na_2SO_4)	ton	20.00-22.00	25.00-35.00
Selenium (Se)	lb.	..	2.10-2.15
Silver nitrate ($AgNO_3$)	oz.	..	.46½
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat per 100 lb.	1.35-1.40	..
Bulk, on contract	Flat per 100 lb.	1.35	..
In barrels	Per 100 lb.	1.69	2.40
In bags	Per 100 lb.	1.45	..
Spot orders	.05 per 100 lbs higher		
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06⅝	.06⅜
Sodium hydrate (NaOH) (caustic soda)	Per 100 lb.	3.60	4.16
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	.03⅞	.04⅛
95 per cent	Per 100 lb.	2.33	2.70
Sodium selenite (Na_2SeO_3)	lb.	..	2.35
Sodium fluosilicate (Na_2SiF_6)	lb.	.04¾	.05
Sodium uranate (Na_2UO_4) Yellow or Orange	lb.	..	1.10-1.15
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.45	3.75-4.00
Flowers, in bags	Per 100 lb.	3.10	3.40-3.65
Flour, heavy, in bbls.	Per 100 lb.	2.75	3.05-3.30
Tin chloride ($SnCl_2$)) (crystals)	lb.	..	.43
Tin oxide (SnO_2) in bbls.	lb.	..	.66
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots	lb.	..	1.20-1.90
Zinc oxide (ZnO)	lb.	.07½	.07¾

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to June 24, 1926

		May 1925 Quantity	May 1925 Value	May 1926 Quantity	May 1926 Value	Eleven Months Ending May 1925 Quantity	Eleven Months Ending May 1925 Value	Eleven Months Ending May 1926 Quantity	Eleven Months Ending May 1926 Value
Glass and glass products (total)		.....	$888,993	.....	$792,369	.....	$7,689,027	.....	$7,993,585
Plate and window glass—									
Window glass, common, box 50 sq. ft.		2,162	14,349	2,682	18,078	31,259	161,332	26,759	145,363
Plate glass, unsilvered, sq. ft.		212,682	49,376	94,193	31,652	1,422,447	386,681	1,425,950	345,323
Other window and plate glass	lbs.	216,781	21,713	170,242	20,428	1,874,940	196,422	2,279,227	246,093
Glass containers (bottles, vials and jars)		.....	344,990	.....	245,524	.....	2,741,288	.....	2,510,788
Table glassware, plain		.....	168,117	.....	146,511	.....	1,619,942	.....	1,586,484
Table and other glassware, cut or engraved		.....	18,601	.....	14,270	.....	159,035	.....	170,457
Lamp chimneys and lantern globes	lbs.	196,681	36,230	223,069	38,372	1,798,693	312,414	1,855,588	367,494
Globes and shades for lighting fixtures	lbs.	113,243	41,596	161,543	49,469	1,354,977	393,807	1,612,425	491,949
Chemical glassware	lbs.	17,945	13,438	15,319	14,151	231,512	180,436	211,573	196,625
Electrical glassware, except for lighting	lbs.	516,169	37,503	686,582	52,271	2,388,885	224,147	3,387,468	350,620
Other glassware		.....	143,080	.....	161,643	.....	1,313,523	.....	1,582,389

IMPORTS

Corrected to June 24, 1926

		May 1925 Quantity	May 1925 Value	May 1926 Quantity	May 1926 Value	Eleven Months Ending May 1925 Quantity	Eleven Months Ending May 1925 Value	Eleven Months Ending May 1926 Quantity	Eleven Months Ending May 1926 Value
Glass and glass products (total)		.....	1,435,428	.....	1,762,137	.....	15,844,739	.....	17,198,755
Cylinder, crown and sheet—									
Unpolished	dut. lbs.	2,821,798	152,624	7,678,711	338,746	38,006,526	2,647,816	50,389,162	2,417,049
Bent, ground, beveled, colored, painted, etc., and polished	dut.	.....	41,702	.....	64,750	.....	487,199	.....	487,902
Plate glass	dut. sq. ft.	1,584,720	759,793	2,263,886	727,787	14,976,529	7,061,233	19,984,999	6,983,288
Containers—bottles, vials, etc	dut.	.....	12,931	.....	36,233	.....	159,394	.....	226,989
Table and kitchen utensils	dut.	.....	8,968	.....	10,168	.....	131,158	.....	129,951
Glassware, cut or decorated	dut.	.....	164,555	.....	175,738	.....	1,943,460	.....	2,381,710
Blown glassware n.e.s.—									
Bottles, ornaments, etc	dut.	.....	81,137	.....	142,097	.....	1,551,451	.....	1,689,696
Bulbs for electric lamps	dut. No.	2,531,301	24,732	1,221,692	15,033	17,689,666	194,337	14,110,915	163,973
Chimneys, globes, shades, etc	dut.	.....	91,503	.....	77,771	.....	1,056,081	.....	934,056
Articles and utensils for chemical, scientific and experimental purposes	dut.	.....	18,824	.....	50,889	.....	283,274	.....	473,697
Other glassware	dut.	.....	78,659	.....	122,925	.....	929,336	.....	1,310,444